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Career Enhancement Key Programs for Development

Logistics Civilian Career Enhancement Program
Logistics Career Broadening Program

also in this edition:

Depot Maintenance Activity Group Funding
Logistics Investment Opportunities
German Wonder Weapons
Career Personnel Information
Inside Logistics

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career enhancement

Logistics Civilian Career Enhancement Program Logistics Career Broadening Program

Logistics Civilian Career Enhancement Program—has met a multitude of challenges with regard to the logistics workforce, while providing management with quality service when filling positions. Through the Base Realignment and Closure in 1995 to implementation of the air and space expeditionary forces to the current Chief's Logistics Review and combat wing organization changes, it has supported the Air Force by providing well-educated, prepared civilian employees and leaders. The program was created to provide central management of developmental and training opportunities for the logistics civilian workforce and provide a central means of referring qualified candidates to management.

Logistics Career Broadening Program—provides aircraft maintenance, munitions and missile maintenance,

logistics readiness, contracting, acquisition, and finance officers a chance to gain specialized knowledge in acquisition logistics and life-cycle sustainment support, but in practice, it is much more than that. The program not only provides unique instruction in logistics but also lends opportunities to grow as a leader and manager. Through the course of the program, the career broadening officer works in various disciplines, learning the functions and challenges of other logistics career fields and earning professional certification in Level I Program Management and Level I Acquisition Logistics. Finally, the participant has an opportunity in the final phase of the tour to concentrate in one area in order to fine tune what was learned in the first phase. This job assignment is usually related to the person's primary logistics specialty.



Logistics Civilian Enhancement P

Career Program

Lynda Lowin

Special Feature

LCCEP Charter: To encourage and manage the development of employees to their fullest potential to meet the logistics needs of the Air Force.

Many employees probably have heard of the Logistics Civilian Career Enhancement Program (LCCEP) but do not realize the impact it has on the logistics civilian workforce. Since LCCEP's inception in October 1980, it has met a multitude of challenges with regard to the logistics workforce, while providing management with quality service when filling positions. Through the Base Realignment and Closure in 1995 to implementation of the air and space expeditionary forces to the current Chief's Logistics Review and combat wing organization changes, LCCEP has supported the Air Force by providing well-educated, prepared civilian employees and leaders.

LCCEP was created to provide central management of developmental and training opportunities for the logistics civilian workforce and provide a central means of referring

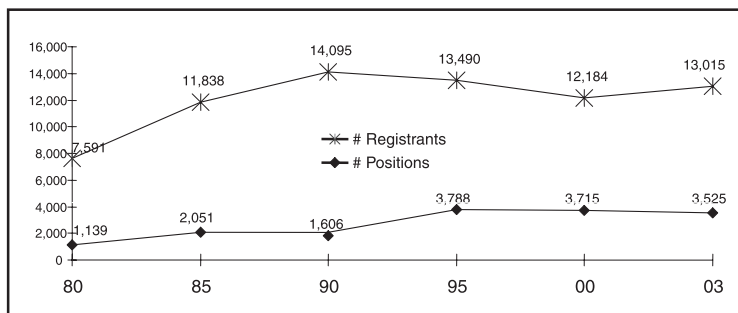


Figure1. Position Coverage and Registrants

qualified candidates to management. The LCCEP PALACE Team at Randolph AFB, Texas, conducts the day-to-day operations of the program.

There are 19 functional civilian career programs within the Air Force, with LCCEP being the largest. In 2003, more than 3,000 positions were covered by LCCEP, with more than 500 referral certificates issued each year. The LCCEP Team is provided management oversight by a policy council composed of senior logisticians. Each career program has a policy council, similar in structure but different in the nature of program activities, to meet mission needs according to its functional requirements.

LCCEP Policy Council

The LCCEP Policy Council oversees the program to ensure requirements are reflected in the development and selection of employees. It has representatives from all major commands (MAJCOM) and air logistics centers and has four executive panels that assist in providing oversight of the program's day-to-day operations (Table 1). These panels work to design, implement, and maintain operational procedures.

LCCEP PALACE Team

The LCCEP PALACE Team conducts the day-to-day operations for the logistics career program. It consists of logisticians from across the Air Force, from a variety of occupational areas, who work with a servicing team of permanent personnel specialists. The team, through its operational programs, provides quality referral certificates, administers the career development program, assesses the logistics workforce, and provides career counseling to logistics employees.

Career Program Positions

General oversight procedures for the civilian career programs are contained in Air Force Manual 36-606, Volume 1. Positions identified and approved by the Policy Council are managed centrally through the career program office. LCCEP covers all GS-13 through GS-15 positions in the series shown in Table 2. Approximately 50 percent of the GS-9 through GS-12 positions are also covered. Requests to fill Career Program-covered positions are processed through the LCCEP Team.

Panel	Purpose
Position Management Panel	Establishes and reviews criteria for position coverage by the program. Develops promotion plans used to provide competitive referral certificates.
Executive Resource Panel	Develops and administers the WPS processes (applies to majority of covered positions) and the Professional Credentials Score (applies to GS-15 covered positions only).
Career Development Panel	Reviews training requirements and criteria and provides general administrative guidance for LCCEP training and developmental programs. Oversees the LCCEP PALACE Acquire Intern program.
Strategic Integration Panel	Develops, evaluates, and implements strategies to integrate Air Force developmental programs that cut across LCCEP programs, initiatives, and activities.

Table 1. LCCEP Executive Panels

1. Primary Series. Occupational series covered only by LCCEP.	
Series	Title
0346	Logistics management
1152	Production control
16XX	General facilities and equipment, equipment specialist
20XX	General supply, supply management, inventory management distribution and storage management, packaging and supply cataloging
2101, 2102, 2130, 2131, 2144, and 2150	Transportation specialist, transportation assistant, traffic management, freight rate, cargo scheduling, and transportation operations
2. Shared Series. Occupational series covered by LCCEP and other programs, depending on the duties and skill coding of the position. Positions must have at least 50 percent logistics skill codes and be in one of the following organizational function codes: AP, AQ, AW, CE, CJ, CR, CS, CY, DC, DD, DF, DT, DU, MA, MM, MT, OP, PA, PB, PP, SE, SU, or TA.	
0301	Miscellaneous administrative
0343	Management and program analysis
1101	General business and industry
1910	Quality assurance
3. Percentage of Coverage by Grade for Primary and Shares Series.	
100 Percent	MAJCOM Determination (up to 50 percent)
GS-13 through 15	GS-12, GS-09 through 11 for series 21XX, GS-11 for series 2032

Table 2. Occupational Series

Program Highlights

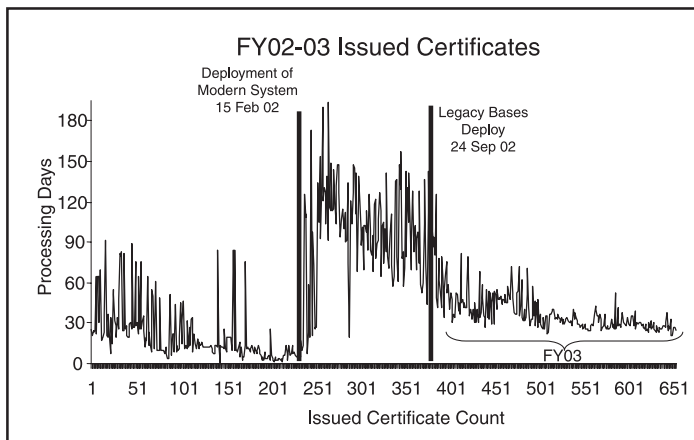


Figure 2. Certificate Processing Trend

Fill Actions

Implementation of the Defense Civilian Personnel Data System (DCPDS), during the last 6 months of 2002, presented a tremendous challenge to the personnel community and the PALACE Team. During this period, LCCEP experienced an increase in the number of requests. A large number of the corresponding referral certificates had to be produced by hand because all installations had not fully implemented DCPDS. The result was an increase in overall processing time. However, once the system was fully implemented in September 2002, certificate-processing time improved greatly, particularly with the internal certificates, to the point they are now averaging 27 days process time from the date the request is received in the LCCEP office. Figure 2 shows the processing time over the last 2 years. Process improvement is continuing, with the objective to significantly reduce processing time to less than 2 weeks.

The Operations Section of the LCCEP Team receives the fill request and announces the vacancy on Air Force Personnel Center (AFPC) and Office of Personnel Management (OPM) Web sites. Air Force employees indicate their interest by self-nominating through the AFPC secure Web site. A promotion plan is constructed by the respective occupational work group from the Position Management Panel. The promotion plan, based on skills needed for the position that is being filled, is used to identify skills, beginning with basic skills, and three other areas, with each area becoming more definitive regarding the quality of experience sought. As an employee's experience record passes through the promotion plan, it is given points in each of the four levels. The promotion plan is used to produce a candidate referral roster, containing the names of all self-nominating candidates, in descending order, based on the number of points awarded based on an employee's experience and

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Approximately 60 percent of the LCCEP training budget supports tuition assistance, which is provided for mission-related courses offered at accredited institutions. Funding follows the guidance of the Civilian Tuition Assistance Program in Air Force Instruction 36-401 and authorizes payment of 75 percent of the semester or quarter-hour tuition.

LCCEP also offers Long-Term, Full-Time, and Part-Time In-Place (PTIP) programs. These programs allow employees to attend college, either full time or part time, and receive their salary. Employees in the PTIP must attend work on a part-time basis to account for the full workday. Annual nominations for these programs are solicited each fall, and senior leader endorsement is required.

One of LCCEP's primary programs for developing employees is the Career Broadening Program. This program provides a 2-year assignment at a location, other than the home installation, and at a different organizational level than that of the participant. It includes 35 positions at the GS-12, 13, and 14 grade levels at a variety of locations.

Whole Person Score (WPS). The top 15 candidates are referred, along with any ties.

Since DCPDS is a *real time* data system, it is important that employees keep their personnel records current. When a promotion plan is run, the system uses the most current information on file. Career briefs are available online through the AFPC secure Web site, and the LCCEP Team recommends that employees review them annually and report any changes or corrections to their servicing civilian personnel flight.

Career Development Opportunities

A tenet of current diversity training, presented to Air Force leaders, is, "Quality is something you must create." LCCEP is mindful of this as it identifies quality developmental opportunities for logistics employees. LCCEP budgets for various education and training opportunities to support individual employee development. All these opportunities are available on the LCCEP Web site. Please note that participation in some programs may require senior leader endorsement.

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If eligible, selection for the program may result in a temporary promotion. Interested employees must meet the prerequisites for self-nomination and obtain a senior leader endorsement and take-back agreement.

Career enhancement positions provide yet another individual career development opportunity. Currently, these positions are provided only through the PALACE Team. However, additional opportunities have been approved that will permit crossflow between Air Force Materiel Command (AFMC) personnel and the operational commands. This program, the Logistics Enhancement Program, will be initiated in fiscal year (FY) 2004. The objective is to provide potential logistics leaders an opportunity to work more closely with military counterparts, often referred to as *bluing*, while providing operational commands a source of AFMC business acumen.

Measuring Career Development

Early in the development of LCCEP, senior logistics leaders recognized the need to foster the knowledge desired for logistics experts. This resulted in the creation of the WPS. The WPS comprises attained experience and education, along with the employee appraisal of record and credit attained for the WPS Assessment Interview (used only for employees eligible for promotion to GS-14). Employees, who self-nominate for announced

Command	Location	Series	Positions
Space Command	Peterson AFB, Colorado	346	1
Air Combat Command	Langley AFB, Texas	346	3
Air Mobility Command	Scott AFB, Illinois	346	1
Pacific Air Forces	Hickam AFB, Hawaii	346	1
HQ Air Force	Pentagon, Washington DC	346	23
Air Force Personnel Center	Randolph AFB, Texas	301	3
United States Air Forces in Europe	Ramstein AB, Germany	346	2
Special Operations Command	Hurlburt Field, Florida	346	1
Total			35

Table 3. LCCEP Career Broadening Position Locations

vacant positions, compete under a promotion plan prepared for the vacancy. They are awarded points from basic eligibility through possession of the current skills of the position, with the WPS being calculated at the same time. Points for WPS are included in the total ranking points attained. The WPS is also used when employees are considered for training and developmental opportunities offered by LCCEP. Because of DCPDS implementation, online WPS capability no longer exists. However, LCCEP is working to provide online capability, which will permit employees to calculate their WPS without having to self-nominate for a vacancy.

The WPS Assessment Interview is conducted annually for promotion-eligible employees to grade GS-14. The interview measures employee responses to questions reflecting the five logistics managerial competencies and results in a maximum of 120 additional points.

Five Logistics Managerial Competencies

- Conceptual and Strategic Thinking
- Self-Confidence
- Initiative
- Entrepreneurial Achievement
- Working Through Others

When logistics employees become eligible to compete for GS-15 LCCEP covered positions, the Professional Credentials Score (PCS) is used to assess and refer candidates. The elements of the PCS are designed to evaluate employee credentials through the use of assessment criteria derived from the Air Force-approved *five pillar* whole person assessment model for developing civilian leadership. The first four pillars (Figure 3) are scored similar to the methodology used for the WPS and are based on data contained within DCPDS. The fifth pillar, managerial competency, is assessed from employee-prepared responses citing credentials toward the five OPM Executive Core Qualifications: Leading Change, Leading People, Results Driven, Business Acumen, and Building Coalitions/Communications. The Managerial Competency Score (MCS) is developed through evaluation of an employee's submitted, self-assessment package by a candidate review board of general officers and Senior Executive Service members. When the resulting MCS assessment points are added to the points credited to the other four pillars or criteria, the result is a PCS, which allows these employees to compete for GS-15 logistics-covered positions.



Figure 3. GS-15 Professional Credentials Score Process

The Future

The goal of Civilian Force Development is to identify cross-functional paths that will expose our civilians to a broader scope of Air Force operational activities in preparation for senior leadership positions

—General John P. Jumper, Chief of Staff

The work of LCCEP continues with its involvement in a variety of leading issues and initiatives such as workforce shaping, human resource capital studies, and force development. The Civilian Force Development initiative, outlined in the Chief's Sight Picture of 2 May 2003, has impacts as yet undetermined. However, it is clear that increased developmental opportunities will be available. Employees and supervisors are encouraged to be vigilant regarding opportunities that enhance individual careers. The Civilian Work Force Development Integrated Process Team has been established to provide a strategic plan with anticipated recommendations to be available in late FY 04.

Contacting the LCCEP Team

The LCCEP Team is here to assist employees with questions and career counseling. It has established a list server to facilitate the communication of policy and program changes and special announcements. All interested employees are encouraged to subscribe to the list server; a link to subscribe is provided on the LCCEP Web site. The following generic e-mail address, LCCEP@randolph.af.mil, may be used when making inquiries or simply communicating with the PALACE Team. Please visit the LCCEP Web site for more information: <http://www.afpc.randolph.af.mil>

Ms Lowin is chief of the LCCEP Career Development Section, located at Randolph AFB, Texas, that oversees the career broadening program, tuition assistance, and other developmental activities for Air Force Civilian logisticians.



Major Frank Alberga, USAF
Major Michael Rollman, USAF
Captain David Boles, USAF
Captain David Spencer, USAF


Special Feature

The Air Force Career Broadening Program provides logistics officers a chance to attain specialized knowledge in their career field.

Are you looking for a challenge? Are you curious what it might be like to work in another logistics career field? Have you ever wanted to see how depot-level logistics operates? Then the Air Force Logistics Career Broadening Program (LCBP) may be just the perfect opportunity for you. (Note that similar opportunities exist for logistics noncommissioned officers. Please consult your supervisor or senior enlisted advisor for more information.)

According to Air Force Instruction (AFI) 36-2111, the LCBP provides aircraft maintenance, munitions and missile maintenance, logistics readiness, contracting, acquisition, and finance officers a chance to gain specialized knowledge in acquisition logistics and life-cycle sustainment support, but in practice, it is much more than that. The program not only provides unique instruction in logistics but also lends opportunities to grow as a leader and manager. Through the course of the program, the career broadening officer (CBO) works in various disciplines, learning the functions and challenges of other logistics career fields and earning professional certification in Level I Program Management and Level I (perhaps even Level II) Acquisition Logistics. Finally, the participant has an opportunity in the final phase of the tour to concentrate in one area in order to fine tune what was learned in the first phase. This job assignment





is usually related to the CBO's primary logistics specialty. From program management to programmed depot maintenance, the opportunities are too extensive to list.

Perhaps the single most important aspect that propels the program to its premiere status is consistent senior leader involvement and participation. Over the years, many senior leaders have said that this active participation is one of the program's greatest strengths. The Deputy Chief of Staff for Installations and Logistics holds primary responsibility, but the Air Force Materiel Command (AFMC) Director of Logistics manages LCBP. Air logistics center (ALC) vice commanders take an active interest in managing their centers' programs by functioning as the ALC advisors for the LCBP. Learning about wholesale logistics expands the CBO's logistics horizons, and we are fortunate our leaders take their mentorship role seriously.

Several different approaches are used to develop the 21 CBOs assigned to the Oklahoma City ALC (OC-ALC). The former OC-ALC Vice Commander, Brigadier General Polly A. Peyer, held bimonthly, brown bag lunches with small groups of CBOs, giving her the opportunity to not only become familiar with the officers but also build solid channels of communication. They discuss the issues of the day and have a chance to speak frankly about various topics, ranging from professional development to current challenges, logistical and otherwise. Another developmental approach involves the use of case studies, based on actual events, which challenges the LCBP officers and prepares them for

Logistics Career Broadening Program

command and greater responsibilities. In addition, homework assignments may be given, usually in the form of readings in contemporary issues, which are studied by the officer, who then must provide written comments in response to specific questions. But all efforts are not simply concentrated in the learning laboratory. CBOs also have an opportunity to work on high-level projects. For example, OC-ALC LCBP officers developed the new Civilian Achievement Medal, built the *Blue School* as an introduction to the military for new civilian hires, and served as action officers for Secretary of the Air Force James G. Roche's Benchmarking with Industry Project. All these developmental opportunities are designed to foster professional growth, not just as logisticians but also as leaders. General Peyer echoed the benefits of the program.

The energy, enthusiasm, and perspective the Career Broadeners bring to an ALC contribute immensely to a center's success. Not only do the Career Broadeners learn about the depot mission and process, but it is a two-way street where Career Broadeners bring their fresh insight to the centers. Most directors clamor for the assignment of a CBO into their programs.

Depot to increase speed and accuracy or redesign engine repair flow to reduce maintenance cycle time. LCBP officers have done these and many other high-impact projects, directly improving depot processes and, in turn, directly enhancing logistics support to the warfighter in the field, all while experiencing a first-rate educational opportunity.

So why should you become an LCBP officer? The reasons are many. For starters, Wal-Mart did not invent the centralized distribution concept, and American Airlines did not invent aircraft overhaul. Many of the processes these modern business giants used were pioneered at the air logistics centers; indeed, the centers are very competitive when compared to their civilian counterparts, and new innovations consistently are being developed and implemented to maintain that competitive edge. Rarely does an officer get an opportunity to participate in such large-scale, cutting-edge logistics. Another unique element of the program is the fact that it deals with an aspect of logistics that wing-level logisticians often do not see completely. Air

Developmental opportunities are designed to foster professional growth in the logistics career field.

At Tinker AFB, Oklahoma, the LCBP officer generally completes seven rotations or assignments in each of the major wholesale logistics functions during the first phase of the program. The rotations have a number of learning objectives, most of which the officer gathers during initial orientation to the new directorate or unit. While in a rotation, the CBO performs work related to the primary logistics discipline of that unit. For example, during a program management rotation within the logistics directorate, the CBO might perform weapon system support functions, such as managing avionics spares for the B-1B Lancer. A maintenance production rotation affords an opportunity to supervise a portion of depot overhaul of aircraft, engines, or accessories, and a contracting rotation teaches the intricacies of buying spares and services. In shorter rotations, the officer might receive a specific tasking that provides a chance to examine the detailed functions of the directorate while still performing meaningful assignments. An example is a study of receiving processes at the Defense Logistics Agency Distribution

Force logistics literally begin and end at the depots as they manage our weapon systems from cradle to grave. CBOs gain the wholesale perspective at an air logistics center, leveraging their knowledge and experience to yield great dividends when they return to the flight line to practice their craft. This improved understanding of the other disciplines enables CBOs to integrate seamlessly with our counterparts, especially during complex undertakings like deployments, resulting in improved mission effectiveness. While working in a staff position, the benefits of the LCBP *learn, do, and lead* concept are multiplied many times over. But the return on the investment is not simply a one-way street. The air logistics centers benefit from the CBO's field-level experience and different perspectives on the problems we face as an air force. Countless times each year, this experience is used to mold depot processes and personnel knowledge to maintain and improve support structures. Bottom line, you get the chance to have a direct influence on service-wide logistics issues from day one, while improving your personal ability to

support the flight-line mission. As we evolve into a force that develops expert officers, groomed to serve in specific duties through force development, a program like LCBP becomes even more important to the Air Force and its ability to produce officers who have depth in their primary career fields and a breadth of knowledge and experience at the depot and field levels.

So you think you are up to the challenge? How do you become an LCBP officer? Each year, a board, chaired by the AFMC Logistics Director, meets to select the best and brightest logisticians from among the applicants to fill a position at one of the three air logistics centers (Oklahoma City, Ogden, and Warner Robbins). Currently, the program is geared toward mid- to senior-level captains with a history of superior performance, potential for promotion to senior-level logistics positions, and full qualification in their logistics specialty. The board evaluates performance and training reports from the previous 5 years, the career brief, and an Air Force Form 3849 (PME/AFIT/RTFB Officer Worksheet). However, it is important to note that to ensure this program maintains the highest standards it is undergoing many changes, some of which may impact the application and board processes. Entry and participation requirements are much stricter, and if applicants donot seem to meet these high standards, then they will not be selected. In recent years, the board even has left available positions open rather than fill them with officers who were not ready for the challenge. Therefore, to be highly competitive, it is important that applicants read AFI 36-2111 and the official message announcing the board in order to submit their package in accordance with current requirements. Supervisors should encourage qualified officers to apply.

In summary, the Logistics Career Broadening Program has evolved into the Air Force's premier program for logistics officers and is producing officers with the potential to fill senior leadership positions, both at the air logistics centers and in the field. It is an opportunity that our best logistics officers should pursue to ensure the continued strength of Air Force logistics now and in the future. Questions can be directed to AFMC/LGXC, DSN 787-5712. Additional information may be obtained at the following Web site: <https://www.afmc-mil.wpafb.af.mil/HQ-AFMC/LG/lgx/lcbp/lcbp3.htm>. For more information regarding LCBP at Tinker: <https://www.tinker.af.mil/lcbp/Default.ht>.

Major Alberga, Major Rollman, Captain Boles, and Captain Spencer are logistics career broadening officers at Tinker AFB, Oklahoma.



Program Highlights

The program provides unique instruction in logistics and lends an opportunity to grow as a leader.

Through the course of the program, the career broadening officer works in various disciplines, learning the functions and challenges of other logistics career fields and earning professional certification in Level I Program Management and Level I Acquisition Logistics. Finally, the participant has an opportunity in the final phase of the tour to concentrate in one area in order to fine tune what was learned in the first phase. This job assignment is usually related to the CBO's primary logistics specialty. The program is geared toward mid- to senior-level captains with a history of superior performance, potential for promotion to senior-level logistics positions, and full qualification in their logistics specialty.

Personnel



Information

Career

Transformation of Logistics Career Field

Captain Adam J. Shirriff, USAF

The Chief's Logistics Review was the catalyst for transformation of the logistics career fields. Specifically, the impetus for refocusing the career fields was the need to develop a greater depth of understanding within logistics core competencies such as aircraft maintenance and munitions. In addition, there was a desire to develop a core of officers who understand the full scope of home-station employments and sustainment and deployment, beddown, and sustainment at contingency locations. A range of processes—receiving, storing, and issuing parts; flight-line operations; and managing the deployment and reemployment phases of an aerospace expeditionary force—was affected by the career-field transformation.

Officers who held the 21S (Supply), 21T (Transportation), and 21G (Logistics Plans) designation had their Air Force specialty code (AFSC) retired and, effective 1 November 2002, replaced by the 21R AFSC. Officers who hold the new 21R designation are known as logistics readiness officers (LRO). The Aircraft Maintenance (21A) and Munitions and Missile Maintenance (21M) career-field AFSC remains the same at the company grade level. However, at the field grade level, aircraft and munitions officers share the duty AFSC of 21B and are referred to as maintenance officers.

The 21L duty AFSC also has been retired. All 21L duty AFSCs now need to be classified as either 21R or 21B. Therefore, if a billet is coded as 21B, it requires either an aircraft maintenance or a munitions officer. Conversely, if a billet is coded as 21R, it requires the skill sets of a logistics readiness officer.

The LRO career field can be divided into various population groups. Knowing which group an officer belongs to determines the professional experience and education an officer needs to maintain currency in the new career field. One LRO group is the *accession* population, which consists of officers who attended the technical training course beginning in July 2002. Another LRO group is the *roundout* population, those who have attended a stovepiped technical training course (core Supply, Transportation, or Logistics Plans). The LRO field-grade population (to include those selected for promotion to major with the October 2002 board results) is classified as the grandfathered population.

To facilitate the professional development of a logistics readiness officer, the Career Field Education and Training Plan (CFETP) was developed, focusing on the key tasks of the three

core logistics competencies: materiel management, distribution, and contingency operations. In addition, six new special experience identifiers (SEI) were created to track an officer's progress as experience was gained in the three core logistics competencies. The six SEIs are Materiel Management (KW), Fuels Management (KY), Vehicle Management (KV), Aerial Port Operations (KT), Contingency Operations (KX), and Distribution Management (KU).¹ A logistics readiness officer can earn an SEI by successfully performing the associated key tasks, as identified in the CFETP, for a minimum of 12 months. The squadron commander certifies the officer completed the required key tasks and spent 12 months in the job. The group commander is the approving authority for the SEI. As a side note, officers with prior enlisted experience who achieved a 7 level in Supply, Transportation, or Logistics Plans can qualify for an SEI, thereby earning a core competency. The squadron commander validates the experience level. In addition, the newly created position of operations officer can qualify for credit. The particular credit needs to be validated using the core task listing associated with the SEI in the CFETP training matrix.

The number of logistics core competencies a logistics readiness officer needs to earn depends on the particular population group to which the logistics readiness officer belongs. Accession officers have 6 years to gain experience in each of the three logistics core competencies. Roundout officers were temporarily awarded the fully qualified AFSC and have until November 2005 to gain experience in one additional logistics core competency to retain the fully qualified AFSC. Grandfathered logistics readiness officers are exempt from the training requirements for logistics core competencies. If a logistics readiness officer is unable to earn the required number of logistics core competencies in the specified timeframe, an extension can be requested from the career-field manager at the Air Staff. For further information on the three logistics core competencies, six SEIs, and corresponding tasks, log onto the Air Force Installations and Logistics Web site (<https://www.il.hq.af.mil/>) and proceed to the Planning, Doctrine, and Wargames Division link.

Exportable correspondence modules in Supply, Fuels, Transportation, and Logistics Plans have been created to complement the experience portion of a logistics readiness officer. Again, certain population groups of logistics readiness officers are affected differently by this education requirement. The accession group is exempt from taking the exportable modules. A logistics readiness officer in the roundout population has to complete the exportable modules in areas where there is no traditional stovepiped schooling. For example, a former 21T transportation officer will need to complete all the exportable modules except transportation. Using another illustration, a former 21S supply officer, who also earned the previous fuels special experience identifier, only will need to complete the transportation and logistics plans exportable modules. The grandfathered population is exempt from having to complete the exportable modules, but they are encouraged to explore what they have to offer. The time line to have these modules completed is November 2004. Officers may enroll in correspondence courses at the base education office.

(Continued on page 45)

Featured Readings

logistics analyses

Depot Maintenance Activity Group Funding Logistics Investment Opportunities: An Economic Analysis

The Planning, Programming, and Budgeting System currently requires operating commands to develop budgets that will cover costs of relevant AFMC support services. They use the Air Force Cost Analysis Improvement Group process to do that. This process divides expected expenses into fixed and variable components and develops a budget estimate for each. "Depot Maintenance Activity Group Funding" examines how the methods used to address the variable component, expressed in terms of cost-per-flying-hour factors, relate to actual costs in Air Force Materiel Command and suggests improvements.

Logistics decisions frequently focus on assessing alternative strategies or courses of action or accepting or

rejecting some investment opportunity. Both situations require more than cost accounting. These are investment decisions requiring economics analysis: upfront costs must be accessed against future benefits or cost avoidance. Decision rule candidates for an economic analysis of alternative actions include the traditional methods of payback, naive rate of return and average return on investment, and the sophisticated methods of internal rate of return, net present value, and benefit and cost ratio. "Logistics Investment Opportunities: An Economic Analysis" suggests the traditional methods of economic analysis are conceptually flawed because they fail to incorporate the time value of money.

Cost Structure of Depot Support Services



Insights from Expenditure and Flight-Hour Data

Depot Maintenance Activity Group Funding

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Frank Camm, RAND

How do logistics costs in Air Force Materiel Command (AFMC) relate to operating command activity levels?

The Planning, Programming, and Budgeting System currently requires operating commands to develop budgets that will cover costs of relevant AFMC support services. The operating commands use the Air Force Cost Analysis Improvement Group (AFCAIG) process to do that. Very roughly speaking, this process divides expected expenses into fixed and variable components and develops a budget estimate for each. We are particularly interested in how the methods used to address the variable component, expressed in terms of cost-per-flying-hour factors, relate to actual costs in AFMC.

In this article, we try to understand better the cost structure of depot support services. How much do these costs actually change when operating command activity levels change? In particular, how much do AFMC depot-level costs change as flying hours change, given that the AFCAIG factors are flying-hour based?

We believe the analysis presented raises questions about how variable costs are reflected in the Air Force command-based budgeting system. Specifically, we find that the expenditures of AFMC's Depot Maintenance Activity Group (DMAG) are inconsistently correlated with flying hours across different systems.

Depot-Level Fixed Costs

We hypothesized *ex ante* that a large portion of depot-level costs is unrelated to operating command activities. For example, programmed depot maintenance (PDM) is scheduled years in advance and is unrelated to current operations. The current AFCAIG process recognizes this phenomenon.

The Air Force command-level budgeting process treats unscheduled maintenance costs in the year of execution as though they were driven by operating command flying hours in that year. We will show that costs actually incurred by AFMC are not related to flying hours in the short run.

For example, materiel procurement has long lead times. Items bought with funds obligated in the year of execution need not be delivered to support flying hours for a year or more. Similarly, items delivered and paid for in the year of execution need not experience a demand in that year.

As we will discuss in more detail below, the organic DMAG has considerable general and administrative (G&A) and overhead costs. By definition, these costs are essentially independent of system activity in any year of execution.

There are also considerable rigidities in the government-employed civilian labor force.¹ Government civilian personnel policy strongly limits AFMC's ability to use temporary labor to match the workforce in place during any period with the demand experienced in that period. Also, the skills required in one maintenance shop are



typically too specialized to allow much substitution of available workers between shops to match fluctuations in shops' demands over time.

Even if labor were freely flexible, AFMC only now is systematically attempting to match maintenance shop priorities to priorities in the operating commands. Until a systematic match can be taken for granted, there is no reason to expect a demand generated by an operating command flying hour to match a maintenance action in AFMC.

What depot-level costs vary, in the short run, with operating command activity levels? The major commands employ operating and support cost factors for depot-level reparables (DLR) based on calculated costs to them per flying hour. Although these factors are quite helpful in forecasting the DLR costs to the major commands, they are much less successful in predicting how a change in flying hours in any month would affect actual AFMC costs during the months following that month. Our analysis suggests that cost factors, like average cost per flying hours, relevant for long-term purposes, have great difficulty explaining how changes in operating command activity levels affect actual depot-level costs to the Air Force in a particular month.

Research Approach

Our analysis focuses on the DMAG, where the majority of AFMC logistics support costs are incurred. The DMAG funds all programmed and nonprogrammed maintenance in AFMC. The DMAG buys materiel from the Supply Maintenance Activity Group (SMAG), but unless this materiel is new, the DMAG is responsible for returning it to serviceable status, so much of what the DMAG pays the SMAG simply covers DMAG costs incurred earlier. The only SMAG costs not actually incurred in the DMAG at some point in the past cover purchases of new materiel and administrative costs within the SMAG; as a result, costs in the DMAG drive total costs in the Air Force working capital fund (WCF).

We examine recorded DMAG expenditures, not AFCAIG cost factors. AFCAIG cost-per-flying-hour factors attempt to capture what the operating commands pay AFMC for services. In this analysis, we do not focus initially on what the operating commands pay AFMC; this is a paper transfer within the Air Force. Instead, we are concerned with the actual costs to the Air Force, as a whole, of supporting the operating commands. AFMC incurs these costs when it pays its labor, buys materiel, pays for utility services, and so on. These are the costs we focus on. We also focus on DLR repair expenditures, not programmed depot maintenance. According to the data we obtained, repair represented 42 percent of DMAG expenditures in fiscal year (FY) 2000.

We focus on specific weapon systems in the operating commands as the drivers of maintenance activities in AFMC. So we focus on the fraction of repair expenditures that is unambiguously attributed to specific mission designs (MD). In FY 00, only about half of organic DMAG repair expenditures were attributed to a specific weapon system. (The rest were attributed to nonsystem-specific categories like engines, turbines, and compressors and communication, detection, and radio equipment.)

We use fleet flying hours as our proxy for operating command activity. As noted above, we do this because the AFCAIG process uses this approach as well. We recognize that other cost drivers may be important.

We then use various lags of fleet flying hours to try to find some relationship with repair expenditures.

H036A Data

Our analysis is based on the DMAG's organic H036A data. These data record monthly accumulated costs in the DMAG by job order number. Each record indicates a month, whether a job is completed or in progress, where the work is occurring, the customer, the mission design, and various types of expenditure (for example, direct civilian labor, materiel, overhead). We have monthly H036A data for fiscal years 1997-2000, inclusive.

The Air Force does not directly use the data in H036A for its own management purposes; it maintains the data to report them to the Office of the Secretary of Defense. We chose to use these data because we were told by several Air Force sources that they provide the best data available for attempting to link MD support costs as closely as possible to actual costs in AFMC. We were able to use the data from H036A to duplicate the DMAG costs that AFMC reported in its FY 00 annual report. This match gives us an important degree of confidence in the data's integrity.

Figure 1 breaks up FY 00 organic DMAG expenditures by materiel, operating overhead, direct civilian labor, and general and administrative for both programmed depot maintenance (Programmed) and component repair (Repair) work. (Figure 1 does not display expenditures categorized as either programmed or repair. The largest such Other categories are Software and Exchangeables Service Work.)

Materiel covers the costs of all DMAG purchases from the SMAG. Note that these are not actual costs to the Air Force as a whole but transfers from the DMAG to the SMAG. So even if we see a strong relationship between activity levels and materiel costs, we cannot infer a strong relationship between activity levels and actual costs to the Air Force in the year of execution.

Operating overhead and general and administrative are clearly fixed costs in the year of execution. Note that operating overhead exceeds direct civilian labor costs. Direct civilian labor represents a distinct minority of organic DMAG expenditures.

Direct civilian labor costs are the most likely cost category shown to reflect a direct relationship between activity levels and actual costs to the Air Force as a whole. But as noted above, they, too, may well display only a limited relationship in the year of execution.

Analysis Foci

We focused our analysis in several ways. We examined only organic expenditures attributed to mission designs. We focused on organic expenditures, because over the period that our data cover, the Air Force gave greater emphasis to tightening order-and-ship times between operating commands and repair facilities for organic than for contract facilities. Similarly, the Air Force gave greater emphasis to prioritizing repairs in organic than in contract facilities. Contract repair also reportedly experienced greater budget-induced turbulence over this period than organic repair, because the Air Force tended to cut contract repair more than organic repair when funds were short. To avoid the likely effects of all these factors, we focused on organic repair, where

we expected to see a cleaner relationship between actual AFMC costs and operating command activity levels.

More prosaically, the organic H036A data are more detailed and descriptive than contract H036A data.

Within organic DMAG expenditures, we looked at total repair costs, which are what the AFCAIG process emphasizes in its treatment of variable costs.

We restricted ourselves to mission designs for which we had monthly fleet flying hours, as well as H036A expenditure data. These mission designs were the B-1, B-52, C-130, C-135, C-141, C-5, F-15, and F-16.

We have flying hours at the MD series level—for example, F-15Cs—but the H036A data tend to only be by mission design; for example, F-15s.

Estimation Procedure

Our basic estimation procedure was to try to estimate the parameters of the equation:

$$\text{Expend}(t) = a + \sum_{i=0}^{i=12} b(i)FH(t-i) + \varepsilon$$

where $\text{Expend}(t)$ is DMAG expenditures in month t in support of this mission design and $FH(t-i)$ is total Air Force flying hours for this mission design in months prior to month t . We regressed, for a given mission design, monthly expenditure data on the current month and 12 months' lags of flying hours. We assume that the residual term, ε , is well-behaved with zero expectation, independence between observations, and a fixed variance.

If increasing flying hours increases expenditures, we expect the sum of the 13 $b(i)$ estimates to be positive.

Linking DMAG Expenditures to Operating Command Flying Hours

Figure 2 roughly describes the DMAG position in the Air Force. The DMAG directly and indirectly supports the warfighter. It provides PDM directly to the warfighter at the flight line. It also provides component repair to the SMAG, which, in turn, provides serviceable parts as needed to the flight line. The SMAG covers all materiel in the Materiel Support Division and base supply.

Our econometric approach measures the extent of a relationship between the wing flight line, where flying hours are measured, and organic component repair shops in the DMAG.

More Flying Hours Increase DMAG Expenditures?

A series of conditions must hold true for increased flying hours to increase DMAG expenditures.

First, more flying must generate more parts needing servicing. We know that the Air Force expects flying hours to drive failures for only a portion of its aircraft-related inventory. In some cases, historical data indicate that another driver—like sorties, cycles, or operational hours—are a better predictor of failures. Failure-induced demand for many items is related to the size of the inventory but not to any specific activity level. And for many items, no empirical relationship has ever performed well enough to be used to predict demands. Items falling into all these categories drive workload in the DMAG. Flying hours are relevant only to those items for which flying hours are the primary

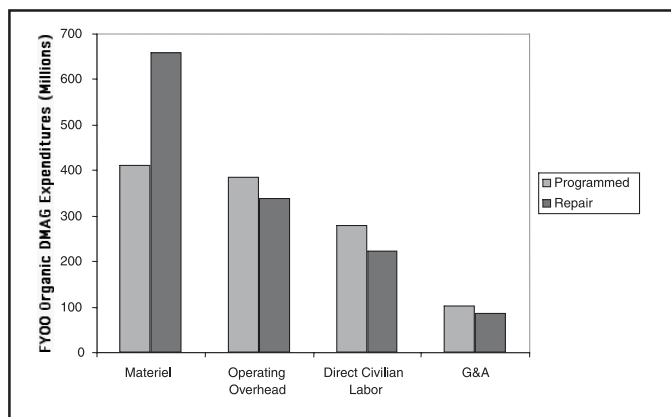


Figure 1. FY00 Organic DMAG Expenditures (Millions)

driver or the primary driver is correlated with flying hours. Any relationship that we capture will be better defined as items with a demand driven by flying hours become more dominant in the DMAG's workload.

Second, these failure-induced demands for additional parts must pass from base maintenance into the SMAG. That is, items that require servicing must generate a demand in base supply. To the extent that base maintenance relies on cannibalized line-replaceable units or aircraft to fill a demand on the flight line, it can delay the time at which a demand is generated in base supply. Within the SMAG, base supply must then pass an effective demand on to wholesale supply. If base supply draws down a stock level, wholesale supply can decide not to fill it immediately and, thereby, avoid passing the demand along.

In the last few years, operating commands increasingly have complained that the SMAG was slow to fill depleted base-level stocks because doing so did not generate sales for the SMAG. To the extent that this is true, the link between a demand generated at the flight line and a demand on the DMAG is further weakened.

Third, the SMAG must pass additional demands for replacement parts into the DMAG. To do so, it must present a requisition and commit resources to cover the cost of servicing the requisition. Because Air Force policy on stock leveling allows the SMAG to receive more requisitions than it can pay for, it will tend to pass on requisitions first for items it will have the least difficulty selling to the operating commands. That is, the SMAG may delay placing a demand on the DMAG to avoid expenditures that would degrade its financial performance. In the extreme, if the SMAG buys too many parts from the DMAG that it cannot sell, it may not have the financial capacity to buy anything from the DMAG for some period, even if the DMAG has resources available to commit to repair.

Fourth, the DMAG must perform additional work. To do so, it must have all the parts required to perform the maintenance, including an unserviceable carcass, and give the repair enough priority to induct the item in question. Without the basic repair capacity and priority, a specific induction can wait, loosening the link between the operating command and depot-level maintenance costs.

Finally, this extra work must increase DMAG expenditures. This assumption is not trivial in that we believe the DMAG has a large number of fixed costs that do not increase with workload.

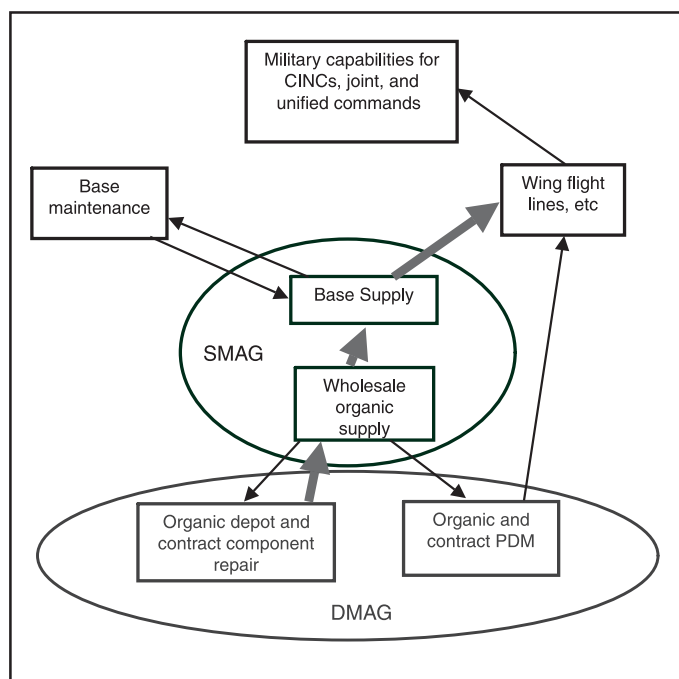


Figure 2. DMAG Position in the Air Force

These concerns make each of the links necessary to connect flying hours and DMAG expenditures problematic. Some failures lead to demands that pass through the supply chain extremely quickly. Other failures generate demands that languish in the supply chain and generate workload in a DMAG shop many months later.

A Noisy Link

In sum, we expect the link between flying hours and recorded DMAG expenditures to be very noisy.

The initial failure process is noisy. Variance-to-mean ratios of 5 or more have been observed for some parts.² With low probabilities of failure, there can be extreme variability from year to year in the number of failures generated by a constant flying-hour program. This variability alone could prevent an analytic method that is suitable for developing long-term, cost-factor averages from yielding useful information for any particular year in the future.

Many demands on the DMAG result not from flying hours but from other measures of operating command activity levels. These exogenous demands are also likely to be highly stochastic, injecting more variation in total DMAG demands that have no direct connection to flying hours at all. Initial demands pass through the supply chain in idiosyncratic ways. Individual supply persons make decisions about prioritization of specific parts that vary based on a number of operational and financial factors.

The distributed lag structure could be estimated to link demand to DMAG costs that reflect the unavoidable delays in the pipeline. However, it could be that the basic lag structure for the logistics pipeline is stochastic and may not be stable over significant periods of time, adding noise to any attempt to identify the underlying structure.

High variance-to-mean ratios in initial demands, variability added from demands not driven by flying hours, and a stochastic lag structure lead to significant variability in demands placed

on the DMAG in any period. These challenges suggest that the realized demands on the DMAG would vary substantially over time, even if flying hours were constant.

In contrast, we know that DMAG overhead and G&A costs are fairly stable. Direct civilian labor is fairly stable. So it is highly unlikely that performed workload in DMAG shops will vary enough to accommodate the demand variability implied by the factors listed above. The DMAG will be managed to absorb this demand uncertainty in an effort to keep its own direct civilian labor fairly steadily employed and limit variability in demand for materiel inputs from the SMAG.

How will such accommodation affect the link between demands in the operating commands and reported costs in the DMAG? Any DMAG activity will accommodate such variation by working down a standing backlog or standing idle when the shop capacity exceeds current demand or allowing a backlog to accumulate when the current demand exceeds shop capacity. Changing the level of backlog simply moves the time when the DMAG services any particular demand from an operating command. Such accommodation is likely to introduce additional discretion that further dilutes any relationship between flying hours and DMAG costs.

Empirical Findings

We found no strong patterns of results that suggest a uniform relationship between flying hours and DMAG organic repair expenditures across weapon systems. To the extent that any relationships exist, they differ substantially across systems.

Both flight hours and DMAG organic repair expenditures vary considerably month to month across all weapon systems studied. Figure 3 illustrates this pattern for the C-135 (covering EC-135s, KC-135s, and RC-135s). The early 1999 spike in C-135 flight hours, for example, is related to North Atlantic Treaty Organization operations in the Balkans.

We observed no straightforward relationship between the DMAG's organic repair expenditure and flying-hour series that is consistent across weapon systems.

Viewing the same C-135 data a different way, Figure 4 plots monthly C-135 flight hours against C-135 DMAG organic repair expenditures covering FY 97-00. There is no obvious relationship. The figure looks essentially the same if one looks at any monthly lag of flying hours as the independent variable.

Formalizing the intuition of Figures 3 and 4, Table 1 presents the results of regressing C-135 DMAG organic repair expenditures on the current month, plus 12 monthly lags of C-135 fleet flying hours.

None of the monthly fleet flying-hour coefficient estimates is significant in Table 1. There is no clear evidence of the C-135 fleet flying hours' influencing organic DMAG C-135 repair expenditures. One possible problem with Table 1 is that the various lags of monthly flying hours are highly correlated with one another, so the estimation should be run with fewer independent variables.

To test this hypothesis, we ran the Stepwise regression procedure where it is endogenously determined which independent variables should be used in the model estimation. Table 2 gives the result of the Stepwise estimation on these data.

The Stepwise procedure chose a much more parsimonious regression structure in the sense of fewer independent variables.

But, reiterating the results shown in Table 1, there is no evidence that C-135 fleet flying hours have a marked impact on DMAG organic C-135 repair expenditures.

The C-135 figures and tables are representative. We see no evidence of a consistent, cross-system relationship between fleet flying hours and DMAG expenditures in accord with use of AFCAIG flying-hour factors for short-run budgeting purposes.

Conclusions and Implications

We expected and found that many DMAG costs are unrelated to flying hours. Programmed maintenance, by definition, is independent of current operating command activity levels. A sizable fraction of DMAG expenditures go to output-invariant costs like general and administrative and overhead. Also, government civilian worker regulations tend to make labor costs hard to quickly reduce. Indeed, Wallace, Kem, and Nelson's 1999 analysis suggested that 80 percent of working capital fund costs are fixed with respect to the amount of depot-level reparable sales.³

Figure 5 is a portrayal of what we think is occurring. The rows show successive activities in the supply chain, from initial activity at the flight line to the depot maintenance shop. Within a row, time moves from left to right; the Xs show events at each stage in the supply chain that can be traced back to the initial flight-line activity.

At the top of Figure 5, we show flight-line activity; that is, flying aircraft. Flying aircraft probably causes some removals at base, though Bachman and Kruse report only low-to-moderate correlation between flying hours and nonoverhaul demand across 50 aviation systems.⁴

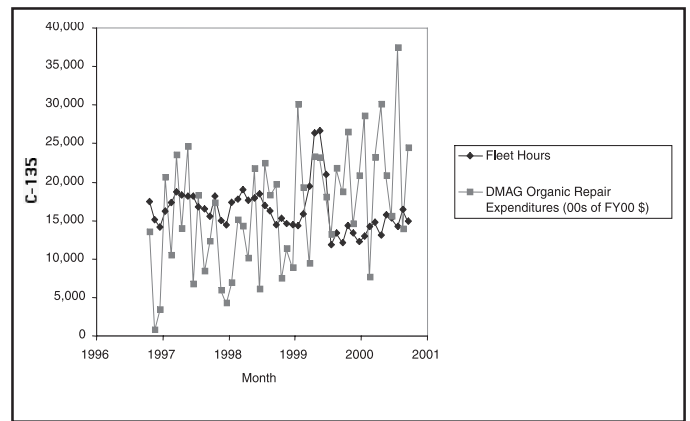


Figure 3. C-135 Fleet Hours and DMAG Organic Repair Expenditures

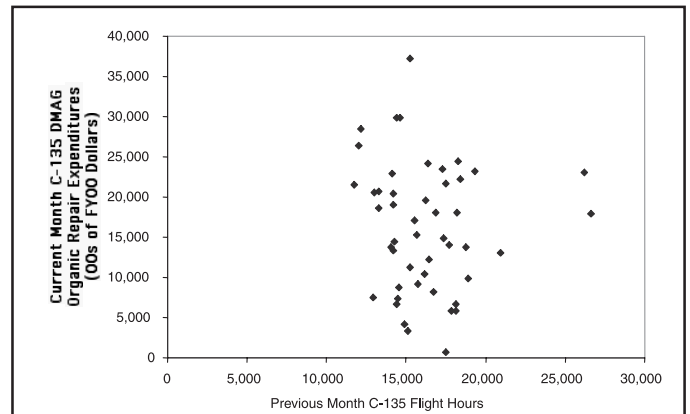


Figure 4. Monthly C-135 Fleet Hours and DMAG Organic Repair Expenditures

Observations		48		
R-squared		0.25		
F		0.89		
Pr>F		0.57		
		Df	SS	
Regression		13	7.6E12	
Residual		34	22.4E12	
Total		47	30.0E12	
	Coefficient	SE	T statistic	P-Value
Intercept	4,460,558	2,194,804	2.03	0.05
Current Month	-6.35	60.98	-0.10	0.92
FH-1	-32.13	78.72	-0.41	0.69
FH-2	39.99	77.63	0.52	0.61
FH-3	-106.24	80.86	-1.31	0.20
FH-4	18.25	80.81	0.23	0.82
FH-5	63.22	81.58	0.77	0.44
FH-6	-152.17	85.53	-1.78	0.08
FH-7	82.67	83.40	0.99	0.33
FH-8	-25.57	83.81	-0.31	0.76
FH-9	-52.16	84.94	-0.61	0.54
FH-10	-91.09	81.40	-1.12	0.27
FH-11	159.26	81.66	1.95	0.06
FH-12	-70.92	65.71	-1.08	0.29

Table 1. Monthly Organic C-135 DMAG Repair Expenditures Regressed on Monthly Fleet Flying Hours, FY97-00

Observations		48			
R-squared		0.11			
F		2.84			
Pr>F		0.07			
		Df		SS	
Regression		2		3.4E12	
Residual		45		26.6E12	
Total		47		30.0E12	
	Coefficient		SE	T Statistic	P-Value
Intercept	1,108,024		726,696	1.52	0.13
FH-10	-90.05		50.92	-1.77	0.08
FH-11	121.06		51.32	2.36	0.02

Table 2. Monthly Organic C-135 DMAG Repair Expenditures Regressed Stepwise on Monthly Fleet Flying Hours, FY97-00

Removals at the base figure cause demands on base supply but, perhaps, with some lags. Similarly, demands on base supply eventually translate into demands on wholesale supply but not instantaneously. Managers in base and wholesale supply make a variety of discretionary decisions that serve to diffuse the relationship between demands at the flight line and depot-level activity.

Wholesale supply demands eventually translate to demands on depot maintenance, but again, the process may be lagged based on inventory statuses, the financial condition of the SMAG, and other factors.

Depot maintenance demands do not translate instantaneously into depot inductions, as the depot system might have various backlogs it is managing. Only when work actually occurs do we see depot-level expenditures recorded in H036A. As depicted in Figure 5, these expenditures may lag considerably, by uncertain length, the activity that ultimately generated the expenditures.

We are not suggesting that flying hours are irrelevant. If the flying-hour program changes, we would expect total demand on depot shops to change eventually. But it will take a long time; the exact effect in any time period will be uncertain; changed demand will not lead to proportionally changed expenditures even in the long run; and until depot capacity actually changes, changed demand is more likely to change the backlog than to change expenditures in the depot.

An Alternative Approach to Budgeting

Our empirical findings are consistent with an alternative approach to budgeting. This analysis suggests that the DMAG has significant fixed costs that we would not expect to change with any measure of activity level in the operating commands. The current AFCAIG process recognizes that PDM costs should be viewed in this way.

We believe many AFMC costs considered variable in the major command budgeting process are also, in all probability, fixed in any year of execution. For example, G&A and overhead costs account for large portions of DMAG component repair costs but should not respond much to changes in repair workload in the depot.

Our empirical results suggest that even costs that many would link directly to component repair costs, like the costs of direct civilian labor, do not vary proportionally with operating

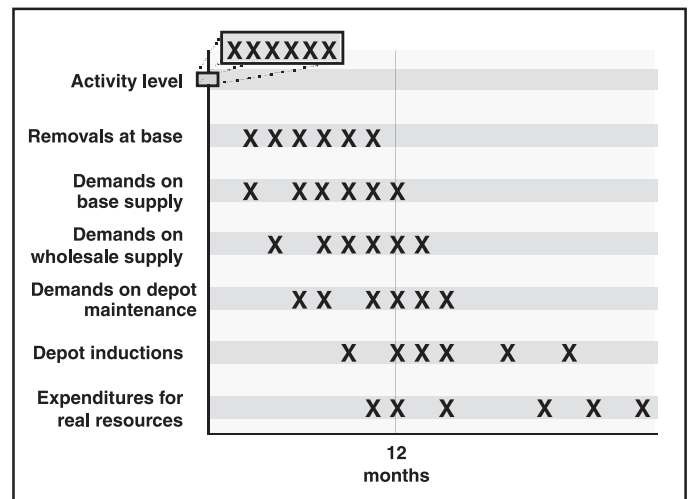


Figure 5. A Conceptualization of the Activity to Depot Process

command activity levels in the months leading up to the month when AFMC incurred these costs. In all likelihood, DMAG costs depend on decisions about capacity made in the past that affect labor costs today.

These results suggest that the Air Force should not budget for costs associated with direct civilian labor or materiel costs in the DMAG shops by assuming they are related to flying hours that occurred in the year leading up to the month in which the DMAG incurred these costs. The logic offered here about uncertainty, lags, discretionary action in the supply chain, and workload smoothing in the DMAG shops helps us understand why no such correlation need be present.

If actual current costs in the DMAG do not depend on current activity levels in the operating commands, budgeting for these costs is more likely to succeed if it addresses the factors that do drive DMAG costs. Suppose current costs in the DMAG depend more on current depot repair capacity than on current activity levels in the operating commands. The Air Force, in effect, chooses a level of component repair capability in AFMC each year and programs resources to provide that capability. In fact, to be successful, ongoing efforts to implement agile combat support and an expeditionary air force must focus on proactively choosing a flexible maintenance capability that can meet future uncertain demands when they arise. Total flying hours in any

year are only one factor relevant to the design and sizing of such capability. There is no reason to expect that agile depot-level support for expeditionary forces should display a cost structure that is proportional to flying hours. Once a robust, flexible depot repair capability is in place, the variable cost of servicing individual flying hours is likely to be small.

We have looked directly only at budgeting in this analysis. But if the empirical results presented here hold up to additional investigation, this budgeting analysis raises questions about WCF pricing as well. The literature on optimal internal transfer prices is very clear that prices should reflect the decisions they are designed to inform. If they inform investment decisions, they should reflect all future costs of investment; if they inform the ongoing use of existing assets, they should reflect only marginal costs associated with marginal use of these assets. Fixed or sunk costs that do not vary with output levels are irrelevant to prices that inform decisions about output.


The new approach to cost recovery and pricing recommended by the Air Force Spares Campaign represents a useful step toward a pricing structure consistent with the findings reported here.

Under this proposal, AFMC would receive a budget to pay for all MSD costs not driven by operating-command activity

levels. Based on the prevailing wisdom about what AFMC costs are variable, the new cost recovery and pricing proposal suggest that WCF prices would include direct labor and materiel costs only. Our empirical findings, if anything, suggest that these costs do not vary directly with flying hours either, at least not within a specific year. Our findings suggest that even a larger portion of AFMC costs might be removed from the working capital fund and budgeted for directly by AFMC.

Notes

1. Albert A. Robbert, Susan M. Gates, and Marc N. Elliott, *Outsourcing of DoD Commercial Activities: Impacts on Civil Service Employees*, Santa Monica, California, RAND. MR-866-OSD, 1997.
2. Gordon Crawford, *Variability in the Demands for Aircraft Spare Parts: Its Magnitude and Implications*, Santa Monica, California, RAND, R-3318-AF, 1988.
3. John M. Wallace, Dale A. Kem, and Caroline Nelson, *Another Look at Transfer Prices for Depot-Level Reparables*, McLean, Virginia, Logistics Management Institute, PA602T1, Jan 99.
4. Tovey C. Bachman and Karl Kruse, *Forecasting Demand for Weapon System Items*, McLean, Virginia, Logistics Management Institute, DL310R1.

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Assessment of Program Costs and Benefits

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An Economic Analysis

Logistics Investment Opportunities

Stephen Hays Russell, PhD

Economic analysis is a formal assessment of the costs and benefits associated with a program or project. The objective of economic analysis is to assess whether the capital outlays (costs) in the current period and the projected benefits for some investment opportunity net an economic advantage to the organization. The intent is to optimize investment decisions by picking worthy projects. In the corporate world, economic analysis is referred to as capital budgeting.

Economic Analysis and Logistics

Application of economic analysis to logistics is receiving increasing emphasis in professional circles. A major focus of recent workshops sponsored by the Logistics Institute at the Georgia Institute of Technology has been financial logistics and economic analysis of logistics investments.¹ Professional logistics organizations, such as the Council of Logistics Management, are now including tracks relating to the financial and economic dimensions of good logistics practices in their annual conferences.²

Sound economic analysis is critical because decisions relating to investment projects chart the course of an organization for many years and, in a sense, *define* the future. Certainly decisions involving a systems engineering tradeoff relating to a Logistics Support Analysis (LSA) task or decisions relating to investing in logistics facilities and other infrastructures, new logistics technologies, or logistics information systems will define a logistics system's efficiency, flexibility, and service levels for many years.

The Time Value of Money

Fundamental to a good economic analysis is the well-established principle that money has a time value. The time value of money principle applies to

any economic analysis that involves time-distributed benefits or costs. For example, cost avoidance over 5 years in a pattern of, say, \$20M-\$10M-\$10M-\$10M-\$10M, is clearly preferred over a pattern of \$10M-\$10M-\$10M-\$10M-\$20M. The first pattern has greater value to the decisionmaking entity.

Does money have a time value in the public sector as it does in the private sector? Absolutely. In an economic context, funds extracted by the government from the private sector have alternative uses and foregone returns. These resources are not *free*. The foregone return is the cost of capital and reflective of the time value of money. The society providing funds to government is better served by an investment in system supportability, for example, that returns savings earlier as opposed to later.

In a Federal finance context, the Government's financial resources on the margin generally come from Treasury borrowing. In this context, the Treasury's borrowing rate is reflective of the time value of money. The time-value-of-money concept for the Government is officially recognized by Office and Management Budget (OMB) Circular A-94.³



Discounting and the Cost of Capital

Discounting is a technique for comparing, on an equivalent basis, alternative courses of action that have varying cost-and-benefit flows. The equivalent basis is the present value of these flows, discounted by the cost of capital.

The three dimensions to an economic analysis using present value are assessing the magnitudes of the relevant cost or benefit flows, determining the period over which these flows will occur, and selecting the appropriate discount rate.

For defense logistics analyses, the appropriate discount rate is the cost of capital to the Government, which is the Treasury's borrowing rate on marketable securities of comparable maturity to the period covered by the economic analysis. The discount rates to be used are published each January in Appendix C to OMB Circular A-94.⁴ Appendix C issued in January 2003 lists a discount rate of 4.2 percent for a 10-year economic analysis period (nominal rate as opposed to a real rate.)⁵

Alternative Decision Rules for Economic Analysis

A logistics economic analysis typically is done in one of two contexts: accept or reject an investment opportunity (buy or not buy a piece of labor-saving equipment, pursue or not pursue a redesign for an additional increment of reliability, as examples) or choose among competing alternatives (for example, test stand A versus test stand B or contractor support versus organic support). In the first context, the structure of the decision rule is to compare the results of the economic analysis to a predetermined accept or reject decision threshold; in the second context, the preferred alternative among the mutually exclusive options is the one for which the decision analysis yields the highest value (or lowest value as appropriate) for the decision rule at hand.

This article surveys six alternative approaches to an economic analysis of logistics investment opportunities: payback, naive rate of return, average rate of return on investment, internal rate of return, net present value, and benefit and cost ratio. The nature, merits, and shortcomings of each of these approaches are considered, with particular emphasis on whether the time-value-of-money concept is incorporated in the decision rule.

Payback

Payback is the straightforward calculation of determining the number of years required to recover the initial investment. In the context of an independent investment decision, if procurement of a piece of support equipment for \$200K saves \$50K a year in labor costs, the payback period is 4 years. This payback period is compared to the predetermined decision threshold (say 5 years) to make the accept or reject decision.

In the context of mutually exclusive alternatives, the option with the fastest payback is selected.

Payback traditionally has been very popular in the defense community, as it has been in the corporate world. As a decision rule, payback has three distinct advantages. It is easy to calculate; it is widely understood by commanders and others in top management; and it answers an intuitively appealing question: if we approve this project, how long will our funds be at risk?

However, payback has three consequential problems. First, the technique completely ignores returns after the payback period. Consider, for example, one piece of equipment, which, if purchased, avoids \$50K in operating and support (O&S) costs over a 5-year useful life and an alternative piece of equipment with the same initial investment, which avoids \$40K in O&S costs over an 8-year useful life. The payback rule will select the first piece of equipment even though a rational logistician would likely view the second option as better.

The implication of using payback is clear. The decisionmaker, perhaps by default, is emphasizing short-run gains to the exclusion of long-term cost optimizing.⁶

Second, theory provides no basis for choosing an accept-or-reject threshold. For example, the Air Force Fast Payback Capital Investment Program of prior years required that a proposed purchase of investment equipment have a 2-year payback to qualify under the program. Why 2 years? Why not 1.9 years or 5 years? What is the logic? What is the theoretical underpinning for the decision threshold?

Third and most significant, payback ignores the cost of capital. The method disregards patterns in cost and benefit flows over time (the time-value-of-money concept). Under payback, a logistics investment that returns, say, \$50M-\$50M-\$10M is not preferred to one that returns \$10M-\$50M-\$50M.

Consider a decision rule that a logistics investment must return 4 to 1 within 5 years.⁷ Such a rule is a payback, specifically a fourfold payback in 5 years. Why fourfold? Why 5 years? Why ignore returns beyond 5 years? Why is cost of capital disregarded? Such a rule is not sophisticated; rather, it is flawed.⁸

Naive Rate of Return

Decision analysts who employ payback often mirror the concept in terms of a rate of return. They speak of the reciprocal of the payback period as a *percent per year rate of return*. For example, a project with a 4-year payback would, under this concept, reflect a 25-percent-per-year rate of return.

Because the concept ignores the compounding effect of a true rate of return and does not consider returns beyond the payback period, the literature dubs the concept *naive rate of return*.⁸ It has precisely the strengths and shortcomings of the payback method albeit embellished as a *percent per year rate of return* concept.

Average Return on Investment

Decreasing in popularity, but still encountered, is the concept of dividing the average return (cost avoidance or other *dollarized* benefit measure) net of depreciation expense over a project's life by the average investment [defined as (initial investment less salvage value)/2].

For example, a \$20M investment with a 10-year life and zero salvage value yielding average cost avoidance, less depreciation expense of \$1M per year, would yield an average return on investment (AROI) of 10 percent.

The advantages to average return on investment are that it is easy to understand, does not ignore any benefit periods in the project life, accounts for salvage value as applicable, and reflects a more plausible rate-of-return concept than does the naive rate of return.

The key criticism of average return on investment is that it, too, completely disregards the time value of money and, consequently, is a distortion of a true return-on-investment

concept. Hence, a comparison of an AROI calculation to an interest rate or a yield on a financial instrument is not meaningful.

Internal Rate of Return

The internal rate of return (IRR) is a clear and precise concept: what interest rate equates the present value of the expected benefit flows over time to the initial investment?

The internal rate of return is found by solving the following equation for r :

$$\sum_{t=1}^N \frac{B_t}{(1+r)^t} = I$$

The value of r , which causes the stream of benefits B_t (from period 1 to period N), discounted by interest rate r to equal the initial investment (I), is defined as the internal rate of return; that is, the solution value of r in the equation above is the internal rate of return. (Alternatively, the I term could be subtracted from each side of the equation. Then, the r value, which causes the *net* present value (NPV)—the modified term on the left of the equal sign—to equal zero, would be the internal rate of return.)

Why is the particular value of r , which equates the investment cost of a project with the present value of its future benefits, of interest? It allows us to compare a project's internal rate of return to the Government's cost of capital and becomes the basis for accepting or rejecting the project.

Consider a process design change that requires a major investment in sustaining tooling that also reduces production costs over time. The interest rate that makes the discounted flow of expected cost reductions exactly equal to the new investment in tooling is the internal rate of return for that tooling investment. Suppose the analysis yields an internal rate of return of 8.7 percent. Is such an investment in new tooling warranted? If the Government's cost of capital is 4.2 percent, absolutely. Taxpayers are well-served by having their nonfree, Government-confiscated capital invested in a project that returns 8.7 percent when the cost of that capital is only 4.2 percent.

For competing alternatives to an investment requirement, the project with the highest internal rate of return is selected.

The internal rate of return is conceptually superior to the previous methods. It accounts for the time value of money, its decision rule ties to the cost of capital, and it does not ignore any periods in the project's life. Furthermore, the IRR result can be meaningfully interpreted.

Purported shortcomings of the internal rate of return include the potential for multiple and ambiguous solutions under certain circumstances.¹⁰ Also, the method is computationally challenging without a computer since the IRR solution is found with trial and error.

Net Present Value

The net present value takes all the concepts and advantages of the internal rate of return and packages them into a more usable and, to most analysts, more intuitively appealing approach to decision analysis.

To use this approach, one identifies the cost of capital, discounts the benefit stream by the cost of capital, and subtracts the initial investment. The result is the net present value (*net*

because the initial investment is subtracted, present value because the stream of benefits is discounted by the cost of capital).

The equation for the net present value is similar to the IRR equation:

$$NPV = PV - I$$

$$NPV = \sum_{t=1}^N \frac{B_t}{(1+c)^t} - I$$

where B_t is the stream of benefits over N periods and I is the initial investment.

Here the discount rate, c , is given (it is the cost of capital), and the analyst solves for net present value. (In the case of the IRR equation previously reviewed, the net present value is set at zero, and the discount rate that satisfies the equality is sought as the internal rate of return.)

The decision rule for independent investments in this case is to accept any project that has a net present value *greater than zero*. For competing alternatives, accept the project with the highest net present value.

The advantages to the net present value as a decision rule in economic analysis include all the advantages given for the internal rate of return, plus the fact it is easier to apply than the internal rate of return since the solution is straightforward (not trial and error) and the potential for ambiguous solutions is nonexistent.

Why is the net present value intuitively appealing? The NPV calculation reflects the computed amount by which the proposed investment will add or subtract financial value to the decisionmaking entity.

Does the net present value, a decision rule of exceptional clarity in concept and intent that incorporates the cost of capital and considers all periods of the project's life, have any shortcomings? Three possibilities are sometimes mentioned:

- NPV solutions hang critically on the value assigned to cost of capital. For example, an investment opportunity that has cost avoidance accruing later than sooner is severely penalized if a comparatively high discount rate is used as the cost of capital. This begs the questions of how measurable is the true cost of capital and how accurate is the estimate of the cost of capital?¹¹
- The net present value, being sophisticated, may not be applied easily by lower levels of the organization or as easily understood as payback at the very highest levels of the organization.
- The net present value, as a ranking criterion, can distort comparisons among competing projects of unequal investment size.¹²

The next decision rule addresses this latter concern.

Benefit and Cost Ratio

This ratio is simply the present value (net present value plus initial project investment cost) divided by the initial project investment cost:

(Continued on page 45)



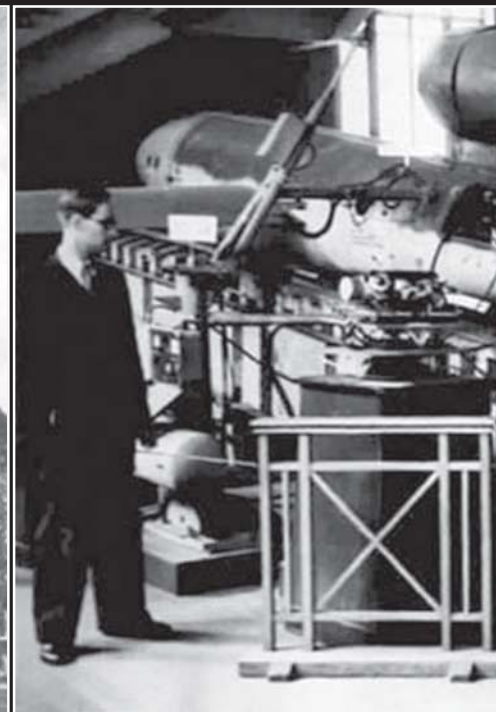
Major Todd J. Schollars, USAF

Introduction

World War II was the greatest conflagration this planet has ever known. It started as a few hegemonic nations annexing territory for economic reasons, then became an ideological battle between right and wrong, and finally ended in a battle of survival for Germany. Facing the Allies' unconditional surrender demands, the Germans combined fervent ideology, a powerful

industrial base, and cutting-edge technology to produce weapons to stave off the Allied tide. The effort was mostly concentrated in developing air weapons, where Germany tried, and ultimately failed, to meet the dual and competing needs of strike and air defense. Germany developed several *wonder weapons* to overcome Allied quantitative superiority. Some of these weapons were obviously flights of fancy, while others served as the basis for many US and Soviet weapon systems in the Cold War. German wonder weapons were a cut above anything the Allies had, yet they were not able to change the tide of war because there were not enough of them on operational status. This fact generates two questions. First, why couldn't the Germans produce and deploy their advanced technology in any effective numbers? Second, if German wonder weapons had reached the front in quantity, would they have made a difference in the war's outcome?

GERMAN WON



The Wonder Weapons

Germany produced a large number of high-technology weapons during World War II. However, unlike the Allies' atomic bomb, electronic warfare, or Norden bombsight, the Germans were unable to reap benefits from their investment.

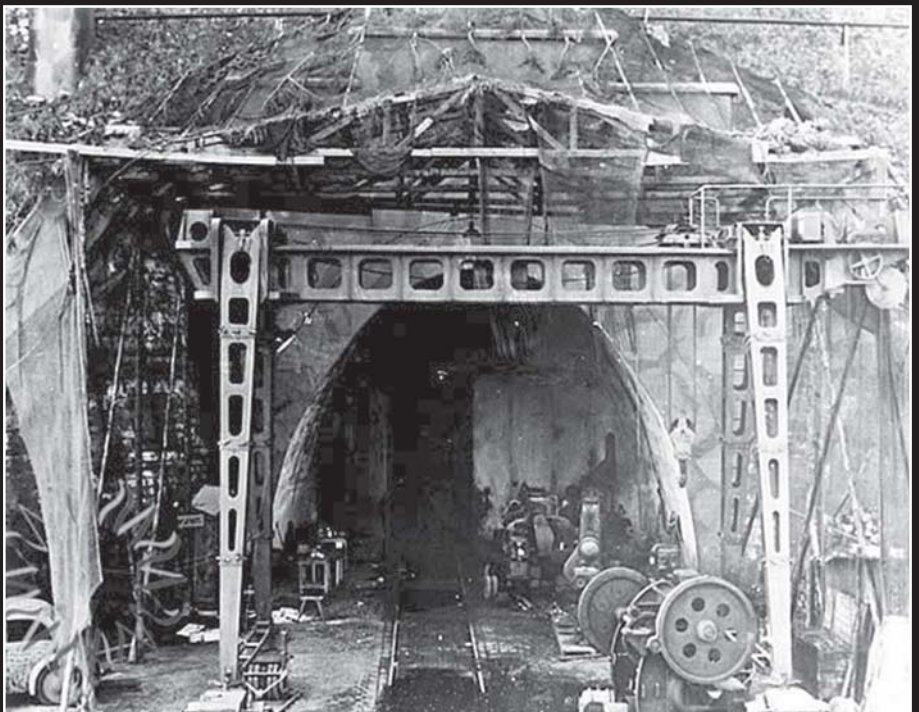
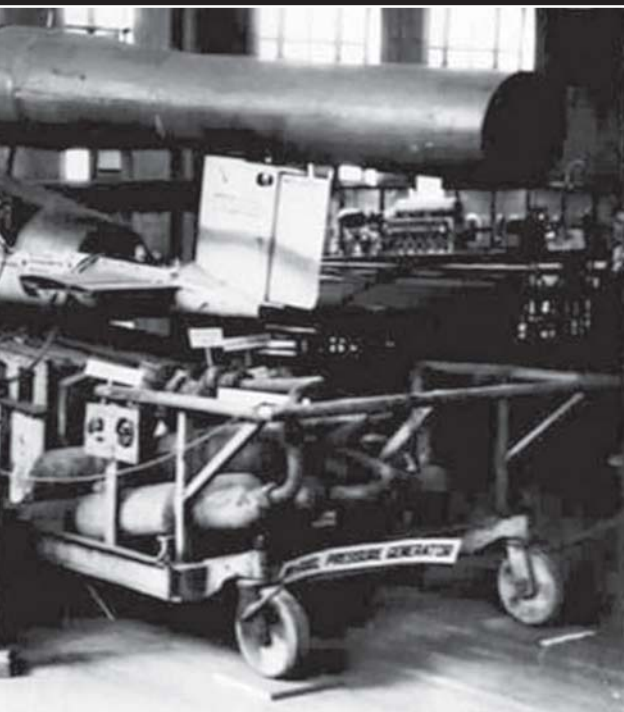
The Messerschmitt Me 262 is, along with the V1 and V2, the best known of Germany's wonder weapons. It could fly at more than 540 miles per hour (compared to the P-51's 437 miles per hour); had an operational ceiling of 37,000 feet; and packed a punch with its four heavy, fast-firing 30-millimeter MK 108 cannon concentrated in the nose.¹ It was so far advanced beyond other fighters that General Adolf Galland, commander of Luftwaffe fighters, declared on his first flight, "It felt as if an angel was pushing."² The technology behind this superb aircraft was the turbojet engine, which produced more power than piston

engines and created less drag than a propeller. The amazing performance of the turbojets shocked Allied aircrews when they first saw the Me 262. It could easily outrun escort fighters, allowing Luftwaffe pilots to dictate the terms of combat. This was especially important for overcoming the Allies' quantitative advantage. Once they were in close, they could deliver devastating fire from their cannon and rocket armament; only a few hits could bring down a heavy bomber.³ The Me 262 clearly made Allied air leaders nervous because it represented the potential for Germany to regain air superiority. However, the aircraft was not without problems.

The turbojets of the 1940s were still in their infant stage and required delicate care from pilots and maintenance personnel alike. Any sudden throttle movements could cause an engine flameout, resulting in deceleration and a lengthy engine restart—not ideal when a pilot was in

DER WEAPONS

Degraded Production and Effectiveness



combat. The high speeds made formation flying difficult, complicating the concentrated attacks essential to breaking up bomber formations.⁴ Both these limitations required highly experienced pilots, something Germany would find in short supply late in the war. Additionally, maintaining the Junkers Jumo 004 engine was time-consuming and needed considerable skill, also in short supply. Each engine had a life of about 15 to 25 hours before needing replacement,⁵ creating both maintenance and logistics supply headaches. Rarely did an Me 262 geschwader (wing with 60 to 90 aircraft) have more than 16 serviceable aircraft for a mission.⁶ Even with these problems, the Me 262 was still a potential *war winner*, if not for production and operational obstacles.

Germany was an early pioneer of air-to-air and air-to-ground rockets and missiles. One of the simplest, yet most effective was the R4M unguided rocket. The Me 262 could carry 24 of these small, simple, easy-to-produce weapons. Their size belied their strength: fired from outside the range of American .50 caliber defensive guns, one R4M had “indescribable efficiency—firing a salvo would hit several bombers—one rocket would kill them.”⁷ The attacks had the added benefit of breaking up bomber formations, making them more vulnerable to other Luftwaffe fighters. R4Ms also had the same ballistic characteristics as the MK 108 cannon, meaning the Me 262 could use the same sight for both weapons.⁸ A more advanced weapon was the X-4, a fin-stabilized, liquid propellant, air-to-air missile, having a speed of 600 miles per hour and a range of 3.7 miles. After firing it from an Me 262 or Focke-Wulf Fw 190, the pilot would guide it to the bomber target via a wire connecting the missile and launching aircraft. Then the missile would detonate on impact or with an acoustic fuze.⁹ The guidance system had the major disadvantage that the pilot could not maneuver his airplane while guiding the X-4, a serious problem considering Allied escort fighters. Germany was developing an acoustically guided version, using a type of sonar to reach the target and explode, but the war ended before it was ready. Had the Germans deployed the R4M or X-4 in significant numbers, it could have dented the Allied bomber offensive. Moreover, since the Luftwaffe was primarily a striking force, German scientists did not confine themselves to air-to-air missiles.

Germany developed two air-to-ground guided weapons during World War II, both used primarily to stem the tide of Allied shipping crossing the Atlantic Ocean. The first was the Henschel Hs 293—a 1,100-pound bomb with 10-foot wings, a tail, and a liquid rocket engine. The launching aircraft would fire the Hs 293 from outside the target ship’s antiaircraft range (possible with the bomb’s rocket), then remote control it via radio during its terminal glide to impact. The Hs 293 only impacted at 450 miles per hour, so it had less penetrating power than conventional bombs and was effective only against merchant ships.¹⁰ The Germans overcame the penetration problem with the Fritz X guided bomb. This weapon did not have any propulsion. Rather, the aircraft dropped it as a normal bomb, then the bombardier guided its steep descent by radio remote control.¹¹ Both the Fritz X and Hs 293 had spectacular success, but Allied defenses overcame these weapons because of limitations cited later. Interestingly, the primary carrier of both weapons was the Heinkel He 177, a bomber whose serviceability greatly limited the bombs’ employment, indicating Germany’s integration problems.

The Germans also used rockets to propel their fighters. Two specific rocket fighters stand out as examples of what Germany was first able to design, then what shortages drove them to implement. First, the Me 163 was a high-performance interceptor. It relied on its flying wing design and single Walter R II-203 rocket engine to produce astonishing performance. It could reach more than 620 miles per hour and climb to 20,000 feet in a little more than 2 minutes. Allied fighters could not touch it, and it presented bomber gunners with a near impossible leading aim calculation. Like the Me 262, however, its propulsion system was not perfect. The fuels were hard to manufacture, extremely corrosive, and would explode if not properly mixed.¹² Further, two of the fuel tanks were beside the cockpit; any vapor or liquid leaks were life-threatening to the single pilot. The rocket burned more than 18 pounds of fuel per second, giving it not much more than 100 seconds of total burn time before the Me 163 became a vulnerable glider. Therefore, while it was a good basic design, lack of further development made the Me 163 operationally ineffective.

The second German rocket fighter was driven purely by economic and pilot shortages. The Bachem (Ba) 349 Natter launched vertically, climbed at more than 15,000 feet per minute, then flew at 600 miles per hour into the Allied formations, where it released its noseful of unguided rockets. Once its fuel was spent, the Natter glided back to base where the pilot ejected himself and the rocket engine—both then parachuted to earth.¹³ The reason for this event was threefold. First, the aircraft structure was cheap and made of noncritical materials, so it could be disposed of. Second, the rocket was difficult to manufacture, so it needed to be saved. German engineers also knew that the shock of landing was likely to detonate any residual fuel, with dire results for the engine and pilot. Finally, the Natter was designed for inexperienced aviators. Since the vertical takeoff required no skills and landings were not attempted, pilot training could concentrate on intercepting the enemy.¹⁴ This was clearly an extreme circumstance brought on by Germany’s desperate situation late in the war.

The final wonder weapons of note were the V1 and V2 rockets, likely the best known of any German weapons. The V1 or Vergeltungswaffe (vengeance weapon) 1 was the world’s first cruise missile. It employed a novel pulse jet engine (which made a distinctive sound, hence the name buzz bomb) and short wings to carry its 1,874-pound warhead to targets up to 150 miles.¹⁵ While the overall idea was advanced, the V1 was actually unguided and flew a straight course until its primitive range-setting device locked the controls and crashed the missile into whatever was below, detonating the V1’s warhead. This obviously was not a precision-strike weapon, but it did kill 6,184 people in and around London. This is still a record number of cruise missile deaths, impressive considering the number the United States has launched in the last 13 years.¹⁶ The V2 was a prewar project designed to attack targets beyond the range of artillery. It was an unguided ballistic missile and the forerunner of today’s intercontinental ballistic missiles and tactical ballistic missiles (the Scud is a direct descendent). The 28,500-pound missile lifted its 2,200-pound warhead¹⁷ in a ballistic trajectory, then plummeted to earth at more than 2,200 miles per hour.¹⁸ V2s were unstoppable after launch; the only way to halt them was bombing the factories or launch sites. V2s inflicted 2,754 deaths in London, Amsterdam, and Antwerp, a record that stood until

the immense Scud exchanges of the Iran-Iraq wars.¹⁹ The V1 and V2 were the only mass-produced and employed wonder weapons. As we will see later, there were several reasons why they were not able to produce the effects Germany needed to turn the tide of war.

It is evident the Germans developed air weapons without equal. However, their failure to mass-produce and deploy these weapons is a monument to *what could have been*. It is important to remember that while the air effort received the most attention, the Germans also developed land and submarine wonder weapons, all theoretically capable of providing the push Germany needed to overcome the Allies.

Production Problems: Why Germany Could Not Deploy the Wonder Weapons

Germany arose from the ashes of Versailles to become a huge economic power. Its industry, technology, and mass-production capacity led Europe and most of the world in the 1930s. So why could Germany not produce its wonder weapons in significant numbers? The problem was not capability. Rather, it was the restrictions and obstacles Germany placed on its industry that affected the production time line of extremely sensitive weapons. Four reasons behind Germany's lack of production are discussed here: political and military interference; the difficulty of mass producing advanced weapons; a lack of strategic vision; and finally, damage and dispersion resulting from the Allies' Combined Bomber Offensive. Any one of the reasons was enough to hamper generating high-technology arms; all four in concert were absolutely crippling.

Political interference was a great obstacle to producing weapon systems and was particularly fatal to advanced systems that required long development times. The political obstruction started early and at the top of the Nazi hierarchy. On 11 February 1940, Hitler canceled all development work that could not get aircraft to the front within 1 year.²⁰ Work stopped on a half dozen major projects, from jets to long-range bombers, all of which would have made the Luftwaffe more capable of fighting a lengthy war. When Germany became desperate for advanced weapons, its hurried response would produce aircraft that had not benefited from full development processes. So confident in early victory were Germany's leaders that they cut the legs out from under the Luftwaffe before the major war really started, denying it any chance of victory in a drawn-out conflict.

High-level conflicts marked the Nazi regime, as Hitler dueling with his advisors for control of the German military's strategic direction. Hitler cut through many of these disagreements by removing dissenters and consolidating power to himself. For example, he already had taken command of military operations when he took control of critical production programs. Although Hitler had a weak technical knowledge of aviation,²¹ he realized the importance of jet engines and personally controlled jet engine allocation after June 1944.²² His tight control took allocation away from production experts. The result was haphazard distribution to manufacturers and operational units, with a corresponding drop in production and aircraft in-service rates. Compounding Hitler's central control was his top officials' fear of or refusal to confront him on decisions they knew were wrong. At best, dissenters received Hitler's extreme verbal abuse, at worst, removal from office. By 1943, Hitler distrusted the Luftwaffe,

and there were many cases of Hermann Goering's passively watching Hitler sow the seeds of his air force's destruction.²³ Even the outspoken Erhard Milch, chief of Luftwaffe production, took orders without objection. When Hitler *uncanceled* the Me 209 program in August 1943, Milch said, "But I have my orders. I am a soldier and must obey them."²⁴ He knew the restart would split Messerschmitt's production between an obsolescent fighter that would never see operational service (the 209) and a potential war winner (the 262). The best and most damaging example of this phenomenon is seen in the saga to produce the Me 262.

The Me 262 jet started development as a fighter and had capabilities far beyond contemporary piston engine aircraft. It was the top priority for production after Galland's first flight and subsequent endorsement. Milch canceled the Me-209 program to devote full attention to the new jet. However, Hitler interfered and restarted Me-209 production, largely out of fear of another failed advanced aircraft (such as the He 177) and its associated risk. There were already several problems with getting the Me 262 into production. Milch knew Hitler's decision to continue the Me 209 would take up space on Messerschmitt's assembly lines and delay operational employment of the Me 262 but went along, happy the Me 262 was still a fighter.²⁵ Unfortunately, Hitler's interference in the program had only started.

Hitler observed Me-262 demonstrations in December 1943 with several staff members, including Goering, Milch, and Galland. After seeing the Me 262, Hitler remarked, "I see the Blitz bomber at last! Of course, none of you thought of that!" Galland, referring to the plane's obvious fighter characteristics, remarked in his autobiography, "Of course, none of us had."²⁶ Milch actually went behind Hitler's back and continued developing the Me 262 as a fighter. When Hitler found out and confronted him at a meeting on 24 May 1944, Milch responded that the plane required extensive modifications and delays to become a bomber. Hitler exploded. "You don't need any guns. The plane is so fast it doesn't need any armorplate either. You can take it all out!" He then turned to the Luftwaffe's director of research, who responded that Messerschmitt could make the modifications without difficulty (actually, removing the guns and armor to make way for bombs would have changed the center of gravity so much Messerschmitt would have had to move the wings). Goering and Galland were so browbeaten, they remained silent, but Milch finally had enough, saying, "Even an infant could see it was a fighter."²⁷ Hitler fired him 2 weeks later. Thus, Hitler's meddling and his highest advisors' ineffectiveness at objecting caused significant delays in a potential war-winning aircraft and led to the dismissal of his best aircraft production coordinator. The Me 262 would eventually become a fighter but too late to be produced in numbers sufficient to wrest air superiority from the Allies. There were other systemic problems with producing the jet fighter, but Hitler's interference made it impossible for Messerschmitt to stick with a firm production schedule. This was only one of several obstacles that kept the wonder weapons out of the air.

High-level interference and bickering were not the only impediments to production. The Luftwaffe's officers contributed as well. Galland remembers rival fanatical groups within the officer corps, some more dedicated to Nazi idealism than actually producing an effective air force. This led to a crisis of trust and leadership, two elements on which depends the fighting strength of any unit.²⁸ Its result was no single voice speaking for the

operational and strategic needs of the Luftwaffe; it also made it difficult for the Luftwaffe to present a united front to deflect high-level interference in weapons programs. Furthermore, we often remember the Luftwaffe as an honorable band of eagles. However, several pilots accepted checks from aircraft companies to endorse their products—planes that were often inferior.²⁹ This, combined with Goering's financial interest in several aviation factories, meant Germany based production choices on personal profit, rather than capabilities. Making inferior planes not only put the Luftwaffe further behind but also took assembly line space away from advanced projects. Military interference also played on a grander scale before the war even started by creating a war industry that could not meet the demands of mass production.

Germany's advanced technology production problems lay both in the character of the industry and pervasive military interference from project inception through delivery. First, German industry was craftsman-based to deliver very complicated weapons.³⁰ This was ideal for creating wonder weapons but made it nearly impossible to mass-produce them. Second, the armaments industry spread its capacity over several different specialized designs. Instead of a core of proven aircraft, German industry had 425 types,³¹ once again hindering mass production and limiting the number of advanced aircraft produced. The reason behind this structure was military fastidiousness—the Wehrmacht liked working with specialized craftsmen because they could respond to the field's demands for weapon changes.³² These changes did make the weapons more effective, but the constantly changing specifications made mass production impossible. No engineers or industrialists were consulted before making changes,³³ creating inefficiencies that further limited production. Finally, the Luftwaffe's first transformation came during the 1930s, when it could upgrade its equipment in peacetime. Conversely, the Allies had to transform early in the war; then stuck with late 1930's technology pushed to its limits, a huge production capacity overcame any qualitative shortfalls. However, Germany tried to transform to wonder weapons late in the war. Transitioning to a superior model in war actually can cause substandard combat readiness and degraded logistics as operators and maintainers learn to deal with new technology.³⁴ The result was German industry produced too little, too late, and actually decreased the Luftwaffe's capability.

Political obstacles, military interference, and an industry ill-equipped to make advanced weapons combined to hinder the wonder weapons' deployment. The cause of these problems was a complete lack of strategic vision, which prevented effective campaign planning and long-term weapons production. The lack of vision began at the highest levels and set a tone of short-range thinking that permeated the Luftwaffe, ultimately crippling its ability to prosecute any kind of strategic warfare. Goering was an extremely able fighter pilot. During World War I, he took command of Manfred von Richthofen's Jasta when the *Red Baron* died in action. However, Goering never gained the technical and logistical perspective needed to command an entire air force.³⁵ Before the war, he abandoned the 10-year prewar plan for a well-staffed and exercised strategic air force in order to attain short-term goals quickly.³⁶ The discarded plan included high-tech weapons, long-range strike aircraft, and the ability to put the German economy on a war basis before hostilities began. Even in early 1941, Goering could have pursued an aggressive program to increase German production but failed to do so. Luftwaffe

military leaders also were more interested in active operations than preparing for the long term, because they desired tactical superiority at the expense of strategic readiness. This resulted from the massive catchup game Luftwaffe personnel played between the wars and made the officers technocrats and operations experts with limited vision. They could not relate airpower to national strategy, and the resulting defects were fatal.³⁷ When losses outstripped production in 1942, the Luftwaffe finally demanded construction increases. By the time the numbers caught up, there were not enough aircrews to fly them.³⁸ The only vision Germany had was a fanatical desire for a technological breakthrough to turn the tide of war,³⁹ relying on a belief in German superiority rather than reasoned strategic planning. Their fanatical desires not only diverted resources from realistic weapons programs but also gave the Allies targets for the Combined Bomber Offensive—the final impediment to German wonder weapons production.

Any discussion of German weapons manufacturing difficulties is incomplete without considering the Allied bombing campaign. Basically, the Combined Bomber Offensive made an already bad situation untenable for manufacturing wonder weapons. The reader must understand the Combined Bomber Offensive did not stop aircraft production—in fact, more aircraft rolled off the lines in 1944 (39,807) than in any previous year (15,904 in 1942, 24,807 in 1943).⁴⁰ However, it caused many operational problems for the Luftwaffe, as we will see in the next section. The Combined Bomber Offensive did cause two major problems with production, negating the impact of increased numbers. First, the bombing forced German industry to disperse, a measure contradictory to mass production.⁴¹ Unlike America's huge aircraft plants like Willow Run, Germany had small factories in many places. While this made Allied targeting more difficult, it also hindered component integration. Different manufacturers also used different tolerances, meaning parts often did not fit together when assembled in the field.⁴² Second, as soon as the Allies saw German wonder weapons in action, they were quick to find and strike the factories. After seeing Me 262s successfully attack a US bomber formation at 100 to 1 odds, General James H. Doolittle told Air Marshal Arthur Tedder, "Something must be done, and done quickly."⁴³ The result was dedicated, systematic attacks on wonder weapon facilities. It is very difficult to mass-produce sensitive, technically advanced weapons with dispersed industry subject to intense bombing. Increased Allied pressure also caused heavy operational losses with which replacements could not keep pace. This attrition was the final explanation for why the Germans could not produce their wonder weapons in significant quantities and turn the war in their favor.

Operational Difficulties: Would the Wonder Weapons Have Made a Difference?

This article has shown the obstacles Germany faced that made wonder weapon mass production and deployment nearly impossible. Even so, it did get limited numbers of its advanced hardware into service. This section will examine whether or not additional weapons would have attained Germany's goals. We must consider both the equipment and other factors such as available crews, training, and the operational constraints imposed by the Luftwaffe's ineptitude and the Allies' air superiority actions.

The first questions we must ask are, were the wonder weapons really that advanced, and if so, were they practical? In many individual cases they were advanced beyond the Allies' equipment, but they were incomplete packages lacking systems integration to other technology. For example, the Me 262 had the devastating 30-millimeter cannon. However, it never reached its full potential because the world's best optics industry could not design a good gyro gunsight that would fit in the jet.⁴⁴ A few experienced pilots learned to overcome the deficiency, but increasing numbers of rookies could not, leading to poor combat performance of an otherwise devastating weapon system. Further, the advanced Me 163 quickly ran short of fuel, then glided back to base. Similarly, the Me 262 flew slowly in the landing pattern, and its sensitive jets precluded any sudden power increases. US fighter pilots knew this and, thus, overcame the rocket and jet menace by orbiting their airfields, waiting to bounce the vulnerable fighters returning to base. This, in turn, forced the Germans to use Fw 190Ds for combat air patrols over their fields,⁴⁵ further exacerbating the fuel shortage. The air-to-ground weapons likewise had their faults. After releasing the Fritz X or Hs 293, the bomber had to fly a predictable course at only 165 miles per hour until bomb impact,⁴⁶ making the lightly armed bombers easy prey for naval fighters. Therefore, while the German wonder weapons were sophisticated, the failure to integrate them into total weapon systems presented vulnerabilities easy for the Allies to exploit.

The advanced technology also presented maintenance headaches for Luftwaffe ground crews. The previous section showed how production problems led to limited spares fabrication and parts incompatibility. Additionally, the emphasis on producing great numbers of new aircraft meant manufacturers were unwilling to *waste* production line space on spare parts, including jet engines.⁴⁷ The result was lower in-service rates for aircraft, because without spare parts, damaged aircraft were not repaired. Instead, ground crews cannibalized what they needed to keep other planes in service.⁴⁸ Cannibalism invariably led to fewer and fewer operational aircraft. The following story shows the effect of these maintenance troubles. Galland visited JG-7 (Kommando Nowotny) to see the Me 262 in action. The wing's leader, 250-kill ace Major Walter Nowotny, wanted a maximum effort to show why the Luftwaffe needed more Me 262s. This maximum effort consisted of 4 planes out of a unit of 80 aircraft; 2 of the 4 subsequently broke before takeoff. US pilots, having overwhelming numbers, then shot down one of the two remaining aircraft when Nowotny's engines malfunctioned during the dogfight.⁴⁹ Germany thus had lost one of its best fighter leaders, who was flying the best aircraft of his career but was let down by a system that could not integrate and maintain it.

Resource shortages forced Germany to use lower technology to gain increased performance. Fuel scarcity led Messerschmitt to experiment with simple steam turbine engines that used 65 percent coal and 35 percent petrol to deliver 6,000 horsepower.⁵⁰ They used the Me 264 long-range bomber as a test bed but were not able to produce and integrate the efficient engines before the war ended. Junkers also developed the long-range Ju 390 and worked on a refueling version to take Ju 290 bombers across the Atlantic. Even if the rumored Ju 390 flight to within 12 miles of New York is true,⁵¹ this wonder weapon still could not hit America where it hurt—the industrial areas of the upper midwest. The same would hold true had the airplane used the coal and petrol engines.

Similarly, the He 162 jet fighter was another step back: its wooden construction used noncritical materials and unskilled labor.⁵² Hitler Youth were the intended pilots, problematic considering the plane's tricky handling. Hitler considered the aircraft and pilots expendable to stop the Combined Bomber Offensive. Fortunately for the young crews, they never flew in combat. While these wonder weapons allowed Germany to concentrate more material and fuel on other projects, they contributed no real capabilities to the Luftwaffe.

The most salient reason the wonder weapons would not have given Germany any advantage was the decreasing skill and experience of Luftwaffe pilots by the time the advanced systems arrived. There were two main reasons for waning crew proficiency. First, many of the best pilots had been killed in action or rendered unfit for duty. Operational losses meant there were few *experten* left in service. In fall 1944 alone, the Luftwaffe lost 12 pilots with 1,146 kills among them.⁵³ This not only decreased Germany's combat capability but also meant there were few *old hands* left to pass on hard-won knowledge to the new pilots. Most had been flying since 1939-1940 (some even had Spanish Civil War experience), giving them unmatched combat experience. However, the lengthy combat time placed a tremendous physical and psychological stress on them. Indeed, Galland noticed the lack of fighting spirit, even in 1943, when he saw several fighters fire on bombers from too far away to be effective, then leave for home.⁵⁴ However, there were some pilots ready to fight, and the limited wonder weapons gave them the spirit to return to duty. When assembling his Me 262 wing, Jagdverband 44, Galland rounded up the most raffish, battle-hardened veterans, several from the pilots rest home. "Many reported without consent or transfer orders. Most had been in action since the first day of the war, and all had been wounded. The Knights Cross, so to speak, was the badge of our unit. Now after a long period of technical and numerical inferiority, they wanted once more to experience the feeling of air superiority. For this, they were ready once more to chance sacrificing their lives."⁵⁵ Unfortunately for them, there were far too few pilots and even fewer superior weapons, those being not advanced enough to matter. Germany had again failed those who served her so well.

The second reason for the decreasing pilot skill was the poor state of the replacement program. Starting early in the war, the Luftwaffe's faith in early victory kept it from increasing the front-line force, so there was no pressure to raise training output.⁵⁶ When heavy losses set in, there was no reserve from which the Luftwaffe could draw. Later, when it realized it needed replacements quickly, the Luftwaffe lowered training time to only 112 hours, with 84 percent of the time spent in basic aircraft instead of high-performance combat types.⁵⁷ This was half the time Allied pilots received. The air force also converted bomber crews to fighters, but the 20 hours' training they received was not enough to prepare them for the rigors of outnumbered fighter combat. Hitler even ordered all fighter groups on the Eastern Front to send two of their best pilots to the Reich's defense forces,⁵⁸ making the German lack of air superiority in Russia even worse. Finally, the Combined Bomber Offensive created a fuel shortage, leading to training curtailment as early as 1942.⁵⁹ Lack of fuel decreased instruction flights, further reducing new pilot skill and experience. All the above meant pilots arriving at the front were not skilled enough to handle basic aircraft, much less employ the highly sensitive wonder weapons (Galland relates how even

his veteran pilots had trouble lining up for kill shots in the very fast Me 262).⁶⁰ This happened at the time Allied pilots were becoming more numerous and better trained as a result of combat veterans rotating home to instruct new pilots. Allied pilots also were becoming more experienced because of lower combat losses and were flying more aircraft of the same caliber as most German fighters. As the Luftwaffe's losses mounted, it closed the advanced schools, then the basic schools, moving the pilots and aircraft to operational units.⁶¹ Replacements stopped just when the wonder weapons were arriving in numbers. Therefore, even with larger numbers of advanced aircraft, the Luftwaffe did not have the crews to fly them, negating their potential effect on the war's outcome.

Several operational reasons kept the wonder weapons, even in greater numbers, from changing the course of the war. Most of these explanations arose from Allied air superiority and the Combined Bomber Offensive's incessant attacks on German industry and transportation. The struggle for air superiority in 1944 made the Luftwaffe commit 82 percent of its manpower and aircraft to defending the Reich.⁶² While this estimate seems high, it does reveal how Germany had to retain forces to protect itself. Further, several wonder weapons, such as the Me 163, were point defense weapons. They were effective defenders but were incapable of extending air superiority over Allied territory or protecting the German Army from Allied close air support and interdiction. Lack of air superiority also meant the Luftwaffe could not conduct offensive operations. This left Germany with no route to victory, as the Allies' goal of unconditional surrender meant Germany could not play a defensive waiting game. Last, defending Germany used many weapons that would have been useful for ground defense and offense. For example, the Luftwaffe employed 10,000 88-millimeter guns as antiaircraft artillery; these guns were also the most effective antitank cannons of the war. Moreover, 500,000 people manned the air defense system, depriving Germany of needed ground troops and factory workers.⁶³ Hence, wonder weapons in sufficient quantity would provide adequate defense but would not have enabled Germany to go on the offensive and push the Allies away from its borders. As it was, Allied close air support and interdiction left Germany no avenue to overcome the numerical superiority of US and British ground forces.

Allied interdiction and the ground offensive also kept the wonder weapons from making a meaningful contribution. Allied armies overran many of the Luftwaffe's front-line airfields after the D-day invasion, forcing the Germans farther to the rear. Their subsequent operations from unprepared fields caused lower serviceability, so the Luftwaffe could not meet Allied quantitative superiority with higher intensity operations.⁶⁴ Relatedly, Ultra intelligence revealed German movement plans and allowed the Allies to attack Luftwaffe ground units en route to their new airbases.⁶⁵ This prevented supplies, parts, and mechanics from arriving to service their airplanes. Finally, the Allies' dedicated attacks on German transportation, especially the railroads, kept new aircraft components from reaching their assembly points (necessary because of the dispersed factories discussed previously). They also destroyed completed aircraft before they could reach combat units.⁶⁶ The wonder weapons were no exception—the Allies knew their value and were intent on killing the airplanes on the ground instead of facing them in the air. Consequently, wonder weapons in greater numbers would

not have had the chance to become operational. If they had, they would be starved for gas; lacking pilots; operating from bases with no ground support; and thus, incapable of making a difference.

History shows that superior aircraft did reach operational units. However, there were employment problems that would have increased had Germany deployed more of the advanced aircraft. First, Hitler was overtly hostile to any defensive measures. This, combined with his control of advanced production, meant fighter and antiaircraft deployments were piecemeal. Hitler believed a more effective defense was to meet terror with terror, causing him to deploy his new weapons in less than optimal ways.⁶⁷ Once airborne, the defenders did have the benefit of aircraft acting as airborne command posts to coordinate attacks.⁶⁸ However, it was only a local measure and did not affect the overall defense of Germany because it could not provide theater-wide situational awareness. Galland sums it up best: "We not only battled against technical, tactical, and supply difficulties, we also lacked a clear picture of the air situation, of the floods coming from the west—absolutely necessary for the success of an operation."⁶⁹ More wonder weapons inefficiently employed would not have improved the situation. They likely would have caused more confusion for the limited C2 system coordinating attacks on the bomber forces.

The final reason for the ineffectiveness of the wonder weapons comes from their secretive development and combat employment. Except for Goering and Milch, the Luftwaffe did not know about the Me 262's development until it was already in advanced testing.⁷⁰ There was no way for the units to develop training or tactics for the new aircraft if the operators did not know the planes were coming. Often a pilot's first experience with the aircraft would be in combat, with less than optimal results. Additionally, when Galland set up his JV-44 jet fighter unit, it was not subordinate to anyone—many felt it had finally shaken the micromanagement that had ruined the program. However, Hitler would not allow JV-44 to have contact with other units, fearing their defensive mindset would contaminate strike units.⁷¹ This isolation was an effective quarantine, meaning the best pilots could not share their skill and experience with other units, especially those trying to employ complex equipment with rookie crews. The new pilots then had little chance to improve except in one-sided combats with Allied fighters. Lack of tactics for the advanced aircraft and the moratorium on sharing expertise would have made more wonder weapons just as ineffective and would have given the Allied fighter pilots easier targets.

The Luftwaffe was unable to prove what it could have done with more wonder weapons, as production difficulties kept it from reaching the operational numbers that could have made a difference. Incompletely integrated technology, decreasing crew skill and experience, a deficient training program, and Allied attacks kept the advanced aircraft in service from effective operations. These problems would have handicapped greater numbers as well. Galland's comment at the war's end concludes it well. When his unit finally received Me 262s, he said:

But this was 1945! In the middle of our breakup, at the beginning of our collapse! It does not bear thinking what we could've done with jet fighters, 30-millimeter quick-firing cannons, and 50-millimeter rockets years ago, before our war potential had been smashed, before indescribable misery had come over the German people through the raids.⁷²

Fortunately for the Allies, the wonder weapons did not arrive on the scene until it was too late to make their mark.

The V1 and V2 Case

So far, we have seen several reasons why the wonder weapons would not have made a difference, even if Germany had deployed them in significant numbers. However, there is a case showing two wonder weapons Germany managed to develop, produce, and use in large quantities: the V1 cruise missile and V2 ballistic missile. This section will further prove the point that greater numbers of advanced armaments would not have made a difference by demonstrating how 35,000 V1s⁷³ and 10,000 V2s⁷⁴ could not change the war's outcome. The primary reasons were the missiles' technology, the theory behind their combat employment, and production interference. It is logical to assume the other wonder weapons would experience similar problems had Germany mass-produced them.

The first topic is numbers. As we saw earlier, Germany built 35,000 V1s and fired 9,200 of them, killing 6,184 people in England.⁷⁵ Likewise, 1,300 V2s hit England between October 1944 and March 1945, killing more than 2,700 and wounding 19,000. V2s had some success degrading Allied logistics with attacks on Antwerp but, on the whole, were another futile effort to turn the war in Germany's favor. Why couldn't huge numbers of these weapons make a difference, especially considering the V2 was unstoppable?

No other countries developed cruise or ballistic missiles during World War II. In fact, the United States and Soviet Union used both the V1 and V2 to create their own systems after the war. However, closer examination reveals the missiles had several of the other wonder weapons' problems: relatively low technology, little systems integration, and minimal reliability. To start, Allied fighters could easily catch the slow (400 miles per hour) V1s and shoot them down. If they were out of ammunition, a few pilots dared to tip the V1s over by placing their wing under the V1's wing and then flicking it up, causing the missile to spin out of control.⁷⁶ The British set up dedicated warning nets to detect the incoming V1s and then sent out interceptors. Royal Air Force (RAF) action thus dispatched 4,000 of the 9,000 V1s fired.⁷⁷ Interestingly, the British kept all their new Meteor jet fighters in England to deal with the missile threat.⁷⁸ However, this was not a victory for the wonder weapons, as the Meteors did not have the range to escort bombers and were not ground attack aircraft either (the Allies already had plenty of aircraft to cover those missions). Vulnerability to interception was not the V1's only problem. A greater fault afflicted it and the V2: lack of accuracy.

While the English could not shoot down the V2s, they and the V1s that penetrated the defenses were extremely inaccurate: V1s had a 12 kilometer of circular error probable (CEP), while V2s had a 6-kilometer CEP,⁷⁹ meaning only half the rounds fired fell in a circle with the CEP's radius. The reason was neither *advanced* system had a guidance computer. The V1 flew straight at a constant speed (the engine actually lost efficiency as it burned, keeping the missile at the same speed even though it was getting lighter as it burned fuel),⁸⁰ then plunged to earth after the primitive air log propeller in its nose had counted the appropriate number of rotations. Once the air log reached the preset number, it locked the V1's controls so it would dive into whatever was below.⁸¹ The Army's V2 was designed as long-

range artillery⁸² and essentially lobbed its warhead beyond gunfire's range. Considering the problems of ballistics, high-speed reentry, and rocket efficiency variations from poor fabrication, it was lucky any V2s hit their targets. Even a simple guidance system would have made the missiles more accurate and, certainly, more a threat to Allied targets. These limitations point to the fact that the V weapons were not that technologically advanced—an issue that reduced their effectiveness.

The V weapons caused relatively few deaths or damage, especially compared to the Combined Bomber Offensive. Three reasons caused the lack of destruction. First, the horrendous accuracy made pinpoint attacks impossible. The Germans did develop a missile-mounted transmitter that stopped signaling when the V1 hit the ground, allowing corrections for the next shot.⁸³ The ever-resourceful British electronic-warfare teams countered this tactic, spoofing the signal to make the weapons miss by even more.⁸⁴ Second, both missiles had very short range: the V1 required launch sites in Holland, with the V2s not much farther back. Even that close to England, the missiles could not reach the heavy industrial areas. Once the Allies liberated Holland, then the rest of Western Europe, the missiles had no way to reach their targets. The only exception was He-111-launched V1s (the first air-launched cruise missiles), which were impractical because of Allied air superiority.⁸⁵ Third, the Allies knew well the capabilities of the V1 and V2, capabilities that would increase if Germany could improve the missiles' guidance. The RAF and the US Army Air Forces also knew where the Germans built and launched the weapons and subjected the installations to unrelenting attack. Once again, the Combined Bomber Offensive created a final obstacle for wonder weapons and made a system that was not making a difference completely useless. With their inherent problems, why then did Germany focus so many resources on building and launching the V weapons? The answer lies in the unique political and military views of the Nazi party.

The lack of accuracy did not bother the Nazis, as the weapons' main purpose was terror, a goal that denied the Germans any chance of effectiveness. Hitler believed they were the *decisive weapons* that would bring him ultimate victory by destroying England and the Allies' will to fight.⁸⁶ Had Hitler looked at his own people, he would have seen the Combined Bomber Offensive's tremendous destruction had not broken their spirit,⁸⁷ even under daily attacks that dwarfed the entire V1 and V2 campaigns. In addition, he should have learned a lesson from the Battle of Britain, where his extreme efforts could not touch the English spirit. While the V weapons did cause psychological strain,⁸⁸ the V1 counter campaign actually had a solidifying effect on British morale. The population eagerly tracked the operation's progress, hailing each interceptor's kill, especially the *tippers*.⁸⁹ England had no counter for the V2, but the people soon realized the low threat from the inaccurate missile, seeing it could only strike populated areas. They had dealt with terror raids before, and with the war going the Allies' way, they saw the V2s for what they were: weapons that could terrorize but not effectively hurt the Allies. Therefore, Hitler's purpose for employing the V1 and V2 actually helped the Allies' cause. At the same time, the weapons hurt Germany's chances for developing other wonder weapons.

The V weapon programs impaired other advanced projects by consuming vast resources and manpower that Germany could

have used to make effective armaments. When Hitler saw a V2 demonstration film on 7 July 1943, he directed that the program receive whatever labor and materials it needed. The program cost more than 5 billion reichsmarks and absorbed tens of thousands of workers (many of them slaves, an additional factor in the poor workmanship)—enough to have produced 24,000 aircraft.⁹⁰ The effort compromised the rest of Germany's war economy and prevented programs from having real strategic worth. One such weapon was the Hs-117 radio-controlled surface-to-air missile,⁹¹ something the Germans needed to counter the Combined Bomber Offensive. The resource expenditure did not stop with the basic missile. Germany pursued two extreme measures to improve the weapons. First, it developed a manned V1 much like the Japanese Ohka kamikaze rocket plane. Unlike the Japanese, the Germans found few volunteers to man the aircraft, even after a test program led by famous pilot Hannah Reitsch.⁹² One can predict the program would have improved accuracy but would have resulted in many deaths from Allied interception before the missiles reached their targets. The second scheme involved a Type XXI submarine (another wonder weapon) towing a V2 that rode in an underwater launch center to its liftoff point near the US east coast.⁹³ Although the designers knew it would have minimal accuracy, they justified the expenditure by saying the weapon's harassing effect would have strategic and political results. Germany produced one of these weapons in the 5 months preceding the war's end but never used it. These problems highlight Germany's complete lack of strategic vision and judgment of what made a successful weapon. The same problems would have affected the other wonder weapons had they reached mass production and deployment.

The V weapons were the only wonder weapons that saw mass production and employment yet had insignificant effect on the war's outcome. The basic problems of integration, poor accuracy, futilely striking morale, and wrongly prioritized expenditures made these wonder weapons, at best, useless, and, at worst, a war loser for Germany. We can see the same problems affecting the other advanced projects as well, showing again what little effect they would have, even in large numbers. In the final analysis, the wonder weapons only promoted the fantasy of the next technological breakthrough that would change the war.⁹⁴ This fantasy was at the expense of practical weapons that could have given the Luftwaffe and Germany a real chance at victory.

Relevance for Today: The US Defense Transformation

Examining the past for historical interest is fine, but it has true value when one applies it to similar events happening today or that could happen in the near future. Adapting a common phrase, one can see that those who do not learn from the past are doomed to repeat it or, at least, will miss opportunities. World War II Germany attempted to transform its war effort with technology but did not have the strategic vision, operational integration, or production capacity to pull it off. One can easily draw a parallel between Germany's efforts and the current US transformation employment. This section will examine the ongoing US military transformation with respect to producing technology, integrating it with other innovations and current weapon systems, then using it to execute national security strategy in a challenging world. Additionally, it will compare German efforts to do the same,

showing the pitfalls on the way toward dominance in all phases of warfare.

Producing high technology has been America's trademark since World War II. During the Cold War, the United States counted on quality to defeat the Warsaw Pact's quantity. Whereas the Germans canceled all programs that could not be completed within 1 year, Secretary of Defense Donald Rumsfeld wants to cancel all projects that do not take the military to the next level.⁹⁵ This is a result of the US strategic orientation toward the long term, rather than focusing on near-term issues. However, the Department of Defense (DoD) must avoid going to the other extreme, because putting all its hope in next-generation weapons will be to the detriment of current and proven technology. Two reasons support this point. First, advanced technology is very expensive, making it difficult to replace combat losses.⁹⁶ The Luftwaffe demonstrated this lesson, and the DoD would be wise to learn it. Second, wars are now *come as you are*, leaving little time to develop new weapons to meet current threats—it could be disastrous to get caught between technological advancements. The key for producing technology is how the United States spends money. Germany could not control its wonder weapons' escalating costs, and it skewed the entire war economy. If the DoD cannot control the exponential cost growth in next-generation weapons, it could price itself out of the defense business altogether. The United States needs to make astute decisions regarding successor weapon systems, in some cases making ruthless choices to ensure it spends money in the right places to produce effective forces within a reasonable time.⁹⁷ Producing technology is important; more crucial is how the military integrates that technology into operations.

Germany failed to integrate its world-leading technology into effective weapon systems, leading to arms that were not as effective as they could have been. Component shortcomings, lack of aircrews, and maintenance problems contributed as well. The current DoD transformation has a better focus. According to Rumsfeld, transformation is more than building high-tech weapons. It is about finding new ways of thinking and fighting. The goal is not to transform within 1 year or even 10 years—it is an ongoing process.⁹⁸ While DoD works the process, it cannot assume new is always better, because integration will always limit high technology⁹⁹ until all weapon components are at the same development level. Additionally, a smaller force of less sophisticated weapons leaves more money for maintenance and upgrades.¹⁰⁰ A good example of this is the recent reduction in the B-1 force, allowing the Air Force to upgrade the remaining bombers to be more effective against moving and time-critical targets. Relatedly, buying versatile weapons can bring down costs, improve integration, and increase effectiveness. The new push for an F/A-22 (vice an F-22) shows the Air Force is moving toward versatile platforms.¹⁰¹ Integrating the technology is vital; equally crucial is taking care of the people who run the weapons. It would be a mistake for DoD to neglect training, retention, and services to pay for new weapons. Germany was unable to use its advanced aircraft for want of experienced aircrews. Current weapons are even more advanced and require the best people to make them effective when the military uses them.

Developing, producing, and integrating technology does no good unless the United States uses its transformed power in an effective way. There are four ways it can employ power to make the fullest use of the transformation. First, the services need clear

concepts of operations (CONOPS) to guide both using the technology today and as a roadmap to the future.¹⁰² Without thoroughly developed CONOPS describing how to employ new weapon systems to meet long-term goals, the DoD runs the risk of short-term thinking. The Air Force is pursuing eight CONOPS, covering everything from space to global strike and mobility, to realize its vision.¹⁰³ Second, the military must use a combination of old and new technology to get the job done. For example, Global Positioning System-guided munitions are superior high-accuracy weapons. However, they are much less effective without a man in the field using simple sighting equipment to find and pass target coordinates to orbiting aircraft. This supports the idea of not placing all hope in fantastic equipment. Third, while fighting the war on terror, the United States cannot become stuck in a defensive mindset like Germany did and lose its capability to strike its enemies. The Secretary of Defense and many other high-level government officials have stated the best defense against terror is a good offense,¹⁰⁴ an appropriate attitude that the United States has so far followed. Moreover, America should be realistic in planning to employ its power. The DoD has finally moved away from the two major wars scenario to a more realistic approach of fighting one major conflict while holding ground in other contingencies.¹⁰⁵ The DoD is doing this by replacing its Cold War threat-based approach with a capabilities-based view. This concept looks beyond current uncertain needs in order to maintain strategic flexibility and resistance to asymmetric surprise.¹⁰⁶ Thus, the capability-based approach directs readiness for the most likely military needs instead of preparing to counter threats that do not pose a realistic danger. Finally, the United States is strongly advocating effects-based operations (EBO).¹⁰⁷ These operations concentrate on achieving effects that will force the enemy to do our will, instead of just destroying targets that produce arbitrary effects. This requires the military to integrate all systems to find, target, and attack those centers of gravity that will make maintaining the status quo impossible for our adversaries. Attacks requiring pinpoint accuracy to eliminate collateral damage are tailor-made for advanced technology, but the United States must ensure it is hitting the right things. Germany squandered its ballistic and cruise missiles trying to attack British morale and ultimately did not attain its goal. The same fate awaits the United States if it does not do its homework to find those things that truly hurt its enemies.

Developing technology while not becoming over-reliant on it, integrating advanced weapons to get full use out of all systems, and using the systems most effectively will allow the United States to avoid Germany's problems. Building a transformation to keep America ahead lets it fight on its terms and keeps enemies off balance and struggling to catch up. The United States must be ready for asymmetric threats and let other countries fantasize about finding their own wonder weapons to change their fortunes. If the DoD transforms correctly, it will not only be ready for them but also may even deter adversaries from using counter technologies against America.

Conclusion

We now know the dominant weapons on the battlefield are the ones that can be mass-produced, operated by motivated fighters, kept in action with spares and supplies, and used in concert with other weapons.¹⁰⁸ Ignoring the above advice in pursuit of superior

weaponry courts disaster. In the words of General George S. Patton, "How easily people can fool themselves into believing wars can be won by some wonderful invention rather than by hard-fighting and superior leadership."¹⁰⁹ Nazi Germany possessed the technical prowess and industry to produce several wonder weapons during World War II. Its jet and rocket fighters, guided missiles, and cruise and ballistic missiles were all ahead of their time and superior to Allied armament. However, Germany could not transform its military into an effective force to stem the rising Allied tide for several reasons.

Germany's first significant problem was producing and deploying its wonder weapons. Many times, Nazi politicians interfered in projects, creating obstacles to efficient production. Further, the military itself played too large a role in design and production specifications, with changing demands making any kind of mass production nearly impossible. Corruption also played a role in keeping incompetent designs afloat, taking valuable production capacity away from truly useful projects. All this boiled down to a lack of strategic vision rising from the Germans' overconfidence in quick victory, a problem that plagued both weapons production and military operations. Finally, the Combined Bomber Offensive made an already horrible system untenable and was the straw that broke Germany's wonder weapons capacity.

Weapons are no good if a country cannot use them. Had Germany actually mass-produced its wonder weapons, it is doubtful they would have done any good. First, the weapons were not that advanced as systems because of German industry's failure to integrate them into total packages. Second, long-term pilot losses led to decreasing crew experience. This, combined with an inadequate training system, meant there were insufficient pilots to fly the wonder weapons. The Luftwaffe compounded the problem late in the war when it completely stripped its training units, sending all pilots and planes to fight. Third, Germany's focus on defense left it little capability to conduct offensive operations to truly hurt the Allies. When it did attack with its only mass-produced wonder weapons, the V1 and V2, it sought only terror effects. Its targeting mistake made the V missiles even more ineffective than their inherent inaccuracy dictated. Additionally, the missile program diverted enormous resources from other projects that could have dented the Allies' progress. In the end, the blade that cut through Poland, France, and the rest of Europe could not be sharpened by the wonder weapons and was ultimately too brittle to survive the exhausting conflict.¹¹⁰ It dulled against the Allies' steel and concrete and was shattered in its turn, ending any chance of German victory.

The lesson Germany failed to learn is relevant today, as the United States moves to transform its military. We must heed the lesson that it is not enough to produce high technology with a short-term strategy. Instead, the United States must make careful choices on what to develop in the budget-constrained economy and fully integrate new weapons with the support systems and people on which they depend. Then it must effectively and realistically employ its transformed military to keep adversaries off balance. Producing, integrating, and employing new wonder weapons to strike targets for effects rather than brute destruction will bend adversaries to US will and allow the United States to attain its national security objectives. Germany lost the

(Continued on page 46)



EXPLORING THE HEART OF LOGISTICS

The Defense Logistics Agency Contributes to Operation Iraqi Freedom

Lieutenant Colonel Susan Declercq Brown, USAFR

Any military campaign is successful because of four things: trained warriors, ammunition, food, and fuel. Without them, it would be difficult to succeed. The Defense Logistics Agency (DLA) provides two of the four: food and fuel. And there is more. In support of Operation Iraqi Freedom, DLA's Defense Supply Center Philadelphia has shipped more than 50 million individual menu bags of meals, ready to eat (MRE). If laid end to end, these MREs would span the continental United States (CONUS) three times. And DLA's Defense Energy Support Center has provided more than 2.5 billion gallons of petroleum and lubricants in support of Operations Enduring Freedom and Iraqi Freedom, enough to supply the CONUS for nearly a week.

DLA is the Department of Defense's largest combat support agency. Vice Admiral Keith Lippert, DLA Director, said, "If a soldier, sailor, airman, or marine eats it, wears it, fights with it, maintains their equipment with it, or in some manner burns it for fuel, DLA likely provided it."

DLA has had its hands full with all the recent events in Iraq. So, too, have logisticians throughout DLA. Air Force Colonel Leonard Petruccelli, chief of DLA's Contingency Plans and Operations until June 2003, said, "To me logistics is that behind-the-scenes operation that is always on—24 hours a day, 7 days a week. Every aspect of our business has to be done right before we can provide the kind of support our Armed Forces deserve."

Petruccelli said the DLA workforce consistently demonstrates incredible dedication and commitment to providing world-class logistics support. As an example, he spoke of the critical role warehouse employees play in the supply process. They receive the property by relying on the information that comes via computers. There is no time or room for second-guessing. If the warehouse staff brings the property in and inputs the data into the computer correctly, then the property and the physical location are going to match. He stated:

It's the guys and the gals who, right after 9/11, when trucks from companies weren't coming, drove the trucks that brought the materials to New York. It's these same people who are preparing tons of cargo 24 hours a day, 7 days a week, and transporting the material to ports for shipment to Operation Iraqi Freedom. You can't ask for a better workforce. The civilians, reservists, and active-duty military who volunteer and deploy are taking the anthrax and smallpox shots, working 14-16-hour shifts, eating MREs, and wearing protective clothing. They're providing vital logistics information to the Combined Forces Land Component Command in Kuwait and US Central Command in Qatar so the component

logistics planners and supply support personnel forward can make good decisions on how to execute this campaign.

New Business Practices for the Current Campaign in Iraq

Three years into the 21st century, it is apparent that the entire logistics and supply chain process has changed. Inventory is not managed like it was in the 1980s and 1990s. Instead of managing large service and wholesale inventories, DLA now manages suppliers. This is an entirely different logistics approach than that used in Vietnam and Desert Storm. Now, much of the warfighter's supplies are shipped directly from manufacturers, distributors, and strategic suppliers.

"We've gotten out of the business of warehousing huge mountains of inventories, but we still manage small hills of critical and high-demand items," said Petruccelli. "We ensure the supplies are delivered straight to where the customer wants them, whether that's an office in Virginia, a pier in Kuwait, or an airfield inside Iraq." He continued:

What also helps us in this campaign is that we are now working hand in glove with the combat commanders and their planners to get out in front of the requirements, and that has been very beneficial because we have been in on the process early. That makes it easier to anticipate needs, and that is what you have to do to support a campaign like this.

In 1999 and 2000, DLA embedded liaison officers at each combatant command, like US Central Command and the Joint Staff. "They've been instrumental in driving good logistics discipline and preparation by integrating DLA's core capabilities into the deliberate and crisis planning process early," said Petruccelli. "You need to anticipate the logistics by working hard in the early planning stages. Working this closely with the combat commanders improves communications and puts everyone in a better position to plan and sustain requirements." To illustrate this point, he used this analogy:

Joint logistics planning with the Army, Air Force, Navy, and Marines is like taking a multiple-choice test where all the answers are correct. There are always many logistics options. The challenge is in meeting expectations, especially when they are complicated by unplanned and special requirements. We see this challenge surface when we get a vertical surge that rockets the demand by a factor of 15 times for some items managed by DLA.

The Supply Chain

“The supply chain starts with our inventory control points—the Defense Supply Centers in Philadelphia, Columbus, and Richmond. They contract directly with our prime vendors, using various contracting tools to access items,” said Petrucci. “We source a product from the United States, then we deliver it to overseas distribution platforms or right to the warfighter—pier side, dining facilities, the flight line, and as far forward as the combat commander tells us to bring the products.”

To get out in front of the time and distance challenges, DLA has worked with the combat commanders and planners to establish sustainment packages that focus on certain high-interest items, such as force protection barrier material and concertina wire. DLA built those packages and sent them by surface so they would arrive prior to the beginning of the campaign, alleviating the burden on strategic airlift. Petrucci said:

Units normally deploy with their unit equipment and a specific number of days of supplies in their basic loads. Once in theater, they begin requisitioning their follow-on sustainment requirements. In this situation, we simultaneously supported the unit’s basic loads, their initial days of supplies as they departed the CONUS, and their sustainment needs. DLA’s direct combat service support is projected to be \$7B more than in 2003 from all these key logistics transactions.

Throughout the advanced planning process, DLA identified sustainment requirements for the number and types of military forces allocated in the war plans. DLA encouraged the armed services to get their requirements in early to ensure all needs were met. Petrucci said that we knew a lot of bulky construction barrier materials would be needed in Iraq. He continued:

These are the types of materials we moved out early in anticipation of the services’ needs. We made a conscious decision not to handle the material twice and overload our depots with inventory, so we moved the materials forward directly from the vendors. We forward stocked these items, which also reduced the burden on strategic airlift assets and kept costs down. We made sure we didn’t overstuff the containers, so units could add to and specially configure the containers.

For the current operation, distance is the biggest challenge DLA has. Contingency support for troops must begin before the conflict, which means demands for clothing, medicines, food, fuel, and construction materials will begin before the troops deploy. Once the conflict begins, large quantities will be needed to support and sustain the thousands of troops in theater. Typically, a pipeline is built. “You really have to look at it as a pipe with a constant flow of water,” said Petrucci. “You want to control the flow so you don’t overwhelm the ports or create an unnecessary need for air shipment.” He said:

Logistics is often framed as both an art and a science, but joint logistics is definitely an art when you’re dealing with services’ idiosyncrasies such as feeding plans, fuel consumption, and water requirements. You don’t want all 100 days worth of food, fuel, and medicines there because you don’t want all your eggs in one basket, to have supplies in the wrong place, or burden the services with managing the additional movement and storage needs. You want to synchronize the flow to sustain a steady state of production, receiving, processing for shipment, en route, to maintain so many days of supplies on hand. You are trying to take products in big bites, but not the whole chunk.

DLA employs radio frequency identification (RFID) tags on containers to track them in transit and make containers easier to find. RFID tags provide additional visibility on what is in transit and what is in theater, and that allows DLA the agility to deal

with change delivery requirements by shifting containers to where they are really needed. “It has been very helpful,” said Petrucci. “It makes it easy for the customer and the deployed DLA contingency support teams [DCST] in the area of operations to track their property and anticipate delivery. That cuts down on reorders.” RFID has proven so valuable that the Department of Defense is requiring that suppliers place RFID labels on products by 2005.

DLA Contingency Support Teams

DLA DCSTs are a total force package of DLA active duty, civilians, and reservists assigned to DLA. Team members, both men and women, come from all services. These teams deploy to the theater of operation and are joined at the hip with the logistics planners in theater. They are the main logistics cells in theater, there to help expedite the requirements. These specialized logistics teams of subject-matter experts are small in number but large in experience and capability. DLA has more than 70 people in the current rotation into the theater of operations. About 20 percent of these are Air Force people. “One Marine Corps flag officer recently commented that his perception of DLA’s competencies had changed since he had been working with the DCSTs,” said Petrucci. “He had never before realized the diverse and dynamic sustainment capabilities DLA brought to the table.”

In the case of Enduring Freedom (Afghanistan) and Iraqi Freedom, the DCSTs give US Central Command the logistics information to assist them in their decisionmaking. They provide information on the products and services available. Based on that information, the services can make ordering decisions to support operations as they change. The DCSTs also help track property when it arrives in theater.

Humanitarian Assistance

In addition to providing full-service logistics in the Middle East, 100 percent of fuel, protective clothing, medical supplies, and nearly all the construction material critical to force protection, DLA also plays a critical role in humanitarian assistance in the region. DLA procures and stores humanitarian daily rations for the Department of State and ships them to the region as required. These rations have been used in both Enduring Freedom and Iraqi Freedom. In March, DLA had already delivered more than 2.4 million humanitarian daily rations to the region—enough food to feed the entire population of St Paul, Minnesota, three meals a day for 8 days. These rations are designed to provide an entire day’s rations for one refugee and are used until that person reaches a refugee camp.

“DLA is proud to provide the Armed Forces two of the four critical elements to a successful military campaign,” said Petrucci. “And it’s an added bonus to play a vital role in America’s humanitarian programs as well.”

As Admiral Henry E. Eccles once said, “The essence of flexibility is in the mind of the commander; substance of flexibility is in logistics.”

Colonel Brown is an Air Force Reservist. She is the Individual Mobilization Augmentee to the director of Public Affairs for the Defense Logistics Agency. She also provides technical writing and marketing consulting services to small businesses in the marine industry.



Supporting Special Operations Forces

Major Travis E. Condon, USAF
Major Kirk A. Patterson, USAF, PhD

Recent terrorist attacks throughout the world and US response to them have revealed the importance and increasing use of special operations forces (SOF). In fact, from 1998 to 2002, special operations forces deployed to an average of 150 countries per year.¹ Furthermore, because of the increased focus on the war on terrorism, the Department of Defense (DoD) has expanded the responsibilities of the US Special Operations Command (USSOCOM). Some of these additional responsibilities include expanding cooperative efforts to work with the geographic unified combatant commands, other government agencies, and international organizations to dismantle terrorist groups threatening US and allied interests.

While most logisticians are proficient with parent service logistics processes, many junior and midlevel logisticians lack the knowledge and experience to effectively provide the joint military support required by special operations forces. However, with increasing reliance on special operations forces to combat terrorism, the geographical dispersion of small units, and expansion of SOF responsibilities and activities, it is inevitable that more logisticians will interface with these special forces. Thus, it has become increasingly important for logisticians to understand better the complexity and uniqueness of the logistical support required by special operations forces.

The primary purpose of this article is to introduce fellow logisticians to several key issues they may encounter when supporting USSOCOM. Better educated logisticians who understand these processes can improve support to the front line and enhance US warfighting capability. More specifically, this article focuses on the distinctive funding and acquisition requirements for unit-level and theater joint staff forces. Understanding the authorization and funding process, getting requirements approved and funded, and sourcing needed equipment and supplies are critical steps to supporting the special operations warrior.

USSOCOM Overview

USSOCOM, headquartered at MacDill AFB, Florida, was activated 16 April 1987² to organize, train, equip, and deploy Army, Navy, and Air Force special operations forces.³ Commanded by a four-star general, USSOCOM is a unified combatant command with three service components:⁴

- US Army Special Operations Command
- Naval Special Warfare Command
- Air Force Special Operations Command⁵

Whereas these service components are continental United States (CONUS)-based and fall under the command of USSOCOM, other special operations forces operate outside the CONUS under the command of the designated unified combatant commander (US European Command, US Pacific Command, and so on). In 1988, a theater special operations command (TSOC) was established in each theater to assist the designated unified combatant commander by providing headquarters support to the special operations forces of each theater. These commands are subunified commands in their respective theater and provide

planning, preparation, and command and control of special operations forces in theater.

The six TSOCs supporting geographic combatant commanders are:

- Special Operations Command Joint Forces Command
- Special Operations Command Central
- Special Operations Command Europe
- Special Operations Command Pacific
- Special Operations Command Korea
- Special Operations Command South⁶

SOF personnel support DoD strategic and operational objectives by providing warfighting skills, capabilities, and tactics beyond the capabilities of conventional military forces. Their missions are often performed in small units in inhospitable locations lacking established or conventional logistics support facilities. The following are the nine principal missions performed by special operations forces:

- Direct Action
- Combating Terrorism
- Foreign Internal Defense
- Unconventional Warfare
- Special Reconnaissance
- Psychological Operations
- Civil Affairs
- Information Operations
- Counterproliferation of Weapons of Mass Destruction⁷

Because of its special missions, diverse organizational structure, and equipment requirements, USSOCOM presents logisticians with complex acquisition and funding challenges.

Common Logistics Support

Joint Publication 1-02 defines logistics as:

The science of planning and carrying out the movement and maintenance of forces. In its most comprehensive sense, those aspects of military operations that deal with: a. design and development, acquisition, storage, movement, distribution, maintenance, evacuation, and disposition of materiel; b. movement, evacuation, and hospitalization of personnel; c. acquisition or construction, maintenance, operation, and disposition of facilities; and d. acquisition or furnishing of services.⁸

The joint publication definition covers all general aspects of SOF logistics, but the responsibility for acquiring and furnishing services and materiel to the special operations forces is often a topic of debate and is vital for the logistician to understand. The responsibility depends on the theater of operation, type of organization, and type of equipment or services needed. A common misconception concerning special operations forces is that they come to the theater self-supporting. This is not the case as special operations forces rely heavily on their respective service or executive agent to provide the bulk of their support.⁹

According to Joint Publication 3-05, unit-level logistics support to special operations forces is a parent service responsibility unless support agreements or directives provide otherwise. This support includes the acquisition and replenishment of all classes of supply, maintenance, transportation, facilities, and services.¹⁰ When special operations forces operate in theater, the TSOC determines SOF logistics requirements for the unified combatant commander.¹¹ The unified combatant commander and theater service component commander ensure effective theater SOF logistics support.¹²

Support responsibility to TSOCs differs from field units because of the joint headquarters function they provide. As previously mentioned, general logistics support to SOF field units is provided by the parent service or executive agent if support agreements have been developed. However, TSOCs are normally supported by a designated lead service (executive agent) responsible for common administrative and logistics support.¹³ As a result, all service-common items authorized in the TSOC Joint Table of Allowance (JTA) are funded by the executive agent.¹⁴ This is often a contentious issue as the executive agent must program for equipment and supplies issued by the other services.

Chairman of the Joint Chiefs of Staff Instruction 4320.01, *Equipment Authorizations for Special Operations Commands*, 15 January 1998, identifies the executive agents for each geographic theater. It specifies that the head of the military departments, as indicated in Table 1, will serve as executive agents and provide or arrange for administrative and logistics support of the headquarters of the commands.

A major exception to these rules is the acquisition and support of special operations (SO)-peculiar equipment. SO-peculiar equipment, materiel, and supplies are procured and provided by USSOCOM. SO-peculiar is defined as those items and services required for SOF mission support for which there is no broad conventional requirement.¹⁵

Some examples of SO-peculiar equipment are the Barrett .50 caliber sniper rifle, MP5 series sub-machinegun, and Stinger night sight.

SO-Peculiar Acquisition

One distinguishing aspect of USSOCOM, critical to its support, is that it is the only combatant command that has its own acquisition authority using Major Force Program 11 for SO-peculiar material, supplies, and services.¹⁶ Acquisition authority provides USSOCOM with the needed flexibility and capability to meet the dynamic requirements of the warriors in the field. Because of this authority, the commander of USSOCOM is responsible for development and acquisition of these items, and the services and logisticians must understand acquisition requests are submitted through service channels vice USSOCOM channels, although direct involvement is unusual. However, logisticians do actively participate in the delivery, accountability, maintenance, and disposition of SO-peculiar items.

Another activity logisticians may be involved with is the monitoring of a combat-mission needs statement (C-MNS)¹⁷ acquisition process when a requirement from the field necessitates quick action for a SO-peculiar item. A C-MNS is defined as follows:

A C-MNS is a single document that satisfies the mission needs statement and Operational Requirements Document in a crisis situation. A C-MNS is appropriate for mission needs identified

Theater	Executive Agent
USEUCOM	Army
US Southern Command	Army
USPACOM	Navy
USJFCOM	Navy
USCENTCOM	Air Force
USSOCOM	Air Force
USFK	Army

Table 1. Theater Executive Agents

during current operations or in preparation of force deployments in response to a crisis or contingency. A C-MNS is normally prepared by the Theater Special Operations Command, endorsed by the theater combatant commander, and submitted to USSOCOM for validation and approval by the Commander, USSOCOM.¹⁸

Submission of a C-MNS gets high-level attention and priority as it is submitted to meet current operational requirements. A C-MNS rapid response team will meet within 24 hours of receipt of the C-MNS and develop a program of actions and milestones necessary to obtain approval from the commander of USSOCOM and facilitate urgent procurement and fielding. The goal is to obtain approval within 48 hours of receipt and provide a readily available, fieldable solution within 60 days.¹⁹

The expeditious fielding of SO-peculiar equipment usually occurs by temporarily or permanently modifying an existing system or subsystem, expediting procurement, accelerating ongoing acquisition programs, purchasing commercial off-the-shelf items, or using an emerging capability advanced enough to warrant initial operational use.²⁰

A recent success story in Operation Enduring Freedom was the delivery of a targeting device. The C-MNS was approved on 26 October 2001 and a contract awarded on 30 October 2001. The initial item was delivered to the soldier in the field a week later. This particular device was very instrumental in pursuing the objectives of Enduring Freedom.

SOF Enablers

To provide responsive worldwide logistics support to SOF personnel, USSOCOM has developed a variety of special service providers and systems. Logistics services include contract logistics operations, supply expeditors, special inventories, and an online SO-peculiar information network. These enablers include the Special Operations Forces Support Activity (SOFSA), Storefront, Joint Operational Stocks (JOS), and SOF Sustainment Asset Visibility and Information Exchange (SSAVIE) and are described in detail below.

SOFSA

SOFSA is a 5-year contract that provides USSOCOM with a dedicated, worldwide logistics support capability that also can be applied to other Government customers on a noninterference basis. SOFSA provides the following services to USSOCOM personnel:²¹

- Logistical and design engineering
- Technical documentation and drawings
- Provisioning
- Operator and maintenance manual support

- Manufacturing or assembly
- Worldwide delivery of products

Storefront

Another avenue of support to the SOF warrior is through a service called Storefront. Storefront is a contractor-provided service that enhances materiel availability and operational readiness of the command's three service components. Storefront provides a wide variety of services to include supply assistance (requisitions, turn-ins, status, expediting), repair and exchange information (source of repair advice, initiate repair and exchange, provide status and reports), and technical assistance (warranty information, vendor information, links to other sites, tracking shipments, JOS management).

The Storefront operation consists of contractor teams at each component headquarters location.

JOS

The JOS program is one of the command's more popular logistical programs. Joint Operational Stocks is a centrally managed, maintained, and stored stock of selected SO-peculiar and high-use equipment. On a loan basis, Joint Operational Stocks provides units with mission-essential equipment to enhance SOF operations.

Listed below are some general examples of JOS inventory:

- Mission Enhancing and Personal Protection—weapons, communication systems, night vision and optics, personal protection
- Bare Base Equipment—tents, generators, field showers, and so forth to augment unit assets for missions
- Contingency Operations—equipment held for unique requirements
- Special Purpose Vehicles—armored SUVs, commercial pickups, ATVs²²

SSAVIE

SSAVIE is a Web-based, SOF logistics portal, providing real-time logistics information. Current SSAVIE capabilities include connectivity to major SOF logistics providers, an online technical and logistics publications library, centralized excess equipment management, selected life-cycle management functions, SOF asset visibility, and a SOF equipment catalog. In short, SSAVIE provides centralized access to SO-peculiar equipment information and support.²³

Summary

The nature of SOF missions, type of equipment used, and interrelationships among USSOCOM, the services, USSOCOM service components, executive agents, and TSOCs provide logisticians with an extraordinary challenge when supporting these *quiet professionals*. As logisticians, we need to become very familiar with and improve on joint logistics, acquisition, funding, and fielding processes to provide the best support to these increasingly important warfighters.

Notes

1. Author's telephone interview with HQ USSOCOM, 11 Dec 02.
2. *Special Operations Forces—Force Structure and Readiness Issues*,

General Accounting Office Report GAO/NSIAD-94-105, Executive Summary, Mar 94.

3. G. Harms, "A Message from the Assistant Chief of Staff for Logistics at headquarters, Naval Special Warfare Command," *Navy Supply Corps Newsletter*, Nov/Dec 99.
4. Unified command—a command with a broad, continuing mission under a single commander and composed of significant assigned components of two or more military departments established and so designated by the President through the Secretary of Defense with the advice and assistance of the Chairman of the Joint Chiefs of Staff, Joint Publication 1-02, *Department of Defense Dictionary of Military and Associated Terms*, 12 Apr 01, 446.
5. Jacobs/Sverdrup [Online] Available: http://www.sverdrup.com/gsa/it/it_enter_ex.shtml.
6. Navy Special Warfare Organization and Capabilities Brief [Online] Available: <http://www.fas.org/man/dod-101/navy/docs/swos/cmd/xpd/SP6-2-5/tsld028.htm>.
7. "Special Operations Forces: Opportunities to Preclude Overuse and Misuse," *General Accounting Office Letter Report GAO/NSIAD-97-85*, Background.
8. Joint Publication 1-02, *Department of Defense Dictionary of Military and Associated Terms*, 12 Apr 01, 248.
9. Executive agent—a term used in DoD and service regulations to indicate a delegation of authority by a superior to a subordinate to act on behalf of the superior. The exact nature and scope of the authority delegated must be stated in the document designating the executive agent. An executive agent may be limited to providing only administration and support or coordinating common functions, or it may be delegated authority, direction, and control over specified resources for specified purposes.
10. Joint Publication 3-05, *Doctrine for Joint Special Operations*, 17 Apr 98, para 5(a), V4.
11. Joint Publication 3-05—para 5, V4.
12. Joint Publication 3-05, para 5(c).
13. Chairman of the Joint Chiefs of Staff Instruction 4320.01, *Equipment Authorizations for Special Operations Commands*, 15 Jan 98, Enclosure A, A-2.
14. The JTA is the TSOC's authorization document to man, equip, and sustain operations. Chairman of the Joint Chiefs of Staff Instruction 4320.01, para 2b, Enclosure B, B2.
15. Joint Publication 3-05, para 5c, V-4.
16. Title 10, Subtitle A, Part 1, Chap 6, Sec 167, para E(4)A(ii). The Major Force Programs: 1—Strategic Forces, 2—General Purpose Forces, 3—Command, Control, Communications, Intelligence and Space, 4—Mobility Forces, 5—Guard and Reserve Forces, 6—Research and Development, 7—Central Supply and Maintenance, 8—Training, Medical, and Other General Personnel Activities, 9—Administration and Associated Activities, 10—Support of Other Nations, 11—Special Operations Forces.
17. USSOCOM Directive 71-4, *Requirements Generation System Special Operations-Peculiar Materiel and Non-Materiel Requirements*, 18 Oct 00, H-1.
18. USSOCOM Directive 71-4, 18, para 8.
19. USSOCOM Directive 71-4, para 18d.
20. *Ibid.*
21. Author's interview with HQ USSOCOM, 5 Dec 02.
22. *Joint Operational Stocks Catalog*, SOF Activity, 8 Jun 02, Sec I, 1, para 1.
23. Author's interview with HQ USSOCOM, 11 Dec 02.

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MEDALS: The Gateway to Technical Data

Warren M. Scott

In October 1985, the Defense Logistics Information Service was directed to establish, maintain, and operate the Department of Defense (DoD) central index and locator system, the Military Engineering Data Asset Locator System (MEDALS). Implemented in October 1988, the MEDALS program serves as DoD's only central locator system for engineering drawings. DoD technical data repositories—which store, maintain, and distribute the engineering drawings—supply the MEDALS program with technical drawing indexing data and associated information. The MEDALS program is linked to the acquisition process of technical data and maintains indexing information throughout the document's life cycle. The MEDALS program, in turn, supplies this information to its customers, along with the drawing locations.

The MEDALS program is an interactive, online system that quickly and easily indicates where engineering drawings or documents reside and provides the user with the information and ability to order it. It is a tool for those who do not know where engineering documents might reside or where all revision levels are located. It also contains information on which repositories are holding specific engineering documents. The program currently provides its customers with the location of more than 36.4 million engineering data assets, located at 31 different data repositories. It indexes information from a family of systems and electronic product data-management systems (ePDMs), the most common being JEDMICS; others include the CENTRA 2000 system located at CECOM, Web-Integrated Data Environment located at NUWC Keyport Washington, and other ePDMs located throughout the Department of Defense. By being the central indexing authority, the MEDALS program can get the customers to the data repositories faster. This benefits the data repositories by saving time, money, and resources by having MEDALS do all the indexing, locating, and pointing the customer to the data repository. The repository does not have to field the queries. Most customers accustomed to using a specific repository will go only to *that* repository to get technical data. However, the MEDALS program provides information about other repositories, which may be holding additional associated drawings that may or may not be located at the customer's accustomed repository. These data may indicate ancillary information associated with the document indexed at the original repository.

The MEDALS program management officer has enhanced MEDALS by taking advantage of advances in the information technology arena. They have done this by simplifying and accelerating research capabilities, incorporating system enhancements, and incorporating customer requirements. The addition of enhanced search capabilities will enable the MEDALS user to navigate more efficiently by providing

alternate search options using links and wildcard searches within the MEDALS program. Hyperlinks to the data repository sign-on and access screens allow the user to perform research functions and view technical data online if a repository supports Web access. The link then returns the user to the MEDALS program for further research. These enhanced features are an asset in today's work environment, moving the customer around to the desired objective faster, easier, and more efficiently.

MEDALS is a graphic-user interface, Web-based system accessible from any personal computer with a Web-secure socket-layer browser capability—Netscape Navigator or Internet Explorer, versions 3.0 or greater. Primarily, MEDALS supports inquiries based on technical drawing information; that is, drawing asset identifier (document and drawing number, Commercial and Government Entity [CAGE] code, document type, and revision level), document/drawing number/CAGE, document/drawing number, and document title. Users also can search for drawings based on associated information; that is, part number, part number/CAGE, and national stock number/national item identification number. In addition to the Web access, the MEDALS program offers the same types of query options in a batch input format, known as batch inquiry, for users with high-volume inquiry requirements. Batch inquiries are submitted for processing online or on compact disk, read-only memory (CD-ROM) and floppy disks/diskettes.

MEDALS supports an online order feature called Electronic Drawing Order Requests (EDOR) that allows authorized users to initiate an order request for engineering drawings distributed on CD-ROM, aperture card, and paper. The program sends the EDOR via e-mail to the appropriate DoD technical data repository, which, in turn, distributes the technical drawing to the requester. For those users with EDOR authority, a history of orders placed within the last 90 days may be viewed. Apart from the query capabilities to locate engineering drawings, MEDALS provides its users with system information through its online bulletin board. The MEDALS Program Management Office posts news items pertaining to MEDALS where users may respond via an e-mail hyperlink.

There is no charge to the customer to request access and use the MEDALS program. The MEDALS homepage can be viewed at <https://www.dlis.dla.mil/medals/>.

For more information on the MEDALS program, its current initiatives, and future enhancements, contact Warren M. Scott (program manager) at warren.scott@dlis.dla.mil (269) 961-5509 DSN 932-5509.

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Karate Helped Define Logistics

Major John Gage, USAF

Logistics is a word used in epic proportions, yet it remains an enigma. It is key to operational success in military and civilian sectors, and people like to shape it and discuss its effects, but defining it proves difficult.

Defining logistics has been my quest for 14 years. This article outlines my personal research and observation and shows the distinction between operations and logistics.

After being assigned as a logistics officer, my first question was “What is logistics?” I still get various and sundry responses. Invariably, people indicate movement of stuff or this classic, “Getting the right stuff, to the right place, at the right time.” That is a desired outcome, not a definition. Further adding to my confusion was the fact that each branch of the service defines logistics differently and that the Joint Staff includes medical as a function of logistics.

My shaping of this definition began while a student under Sensei Alex Merana. He taught two important concepts: life cycles and mind and body.

Sensei taught life cycles by emphasizing kata (a series of blocks, punches, and kicks) and the importance of having strong starts and finishes. That stuck with me and has proven quite insightful. Everything we do has a start and a finish. People certainly have a life cycle, as do weapon systems.

Information also has a life cycle. For example, intelligence agencies acquire data, make them into a product used for decisions, and then dispose of them as guidance. Acquiring, using, and disposing of data are the three basic life-cycle stages.

The concept of mind and body allowed me to properly define logistics. A brave white belt asked, “When will we start weapons training?” Sensei replied, “The word karate means empty-handed;” that is, no weapons. His next statement, however, greatly impacted the definition of logistics. Sensei said, “Weapons are an extension of our hands, which are extensions of our mind. Therefore, everything we do is an extension of our mind.”

This proved to be quite profound. I have deduced that an operation is expressed in action such as a task, service, or mission. Therefore, logistics is the medium by which we carry out operations.

The real separator of my definition is the basic elements. In hosting all branches of the services from several nations in

support of large-scale operations, I categorized commonalities. Semantics precludes this from being readily apparent, but eventually, I developed these five elements: communication, personnel, materiel, infrastructure, and distribution. The interesting thing is that I can relate all these elements to the human body.

Forces need to send and receive information. From planning to manuals to media events and so on, communication is an enormous requirement for operations. The body part relating to communication is the head, as it integrates information sent from sensors and is then expressed via verbal-nonverbal cues, most loudly by our actions.

There are always personnel required in support of operations. Personnel actions usually start with a requirement. Then we recruit, feed, clothe, protect, entertain, and medicate them, but our primary focus is to train them for labor. The body part that relates to personnel is the right hand, based on the saying “He is my right-hand man.”

The third element is materiel. The military maintains and sustains numerous platforms, weapons, support systems, and all their associated parts. Because man distinguishes himself by using complicated tools, I chose the other hand to represent materiel.

Our very own body represents the next element, infrastructure. The skeletal system represents the framework from which we operate facilities, roads, runways, and ports. The digestive system represents our energy system, referred to commonly as utilities; that is, electric, gas, or what have you.

And last, the distribution system is how we move resources represented by legs. Our legs enable us to walk, jump, and swim. Various lift vehicles represent the same: surface, air, and sealift.

Perhaps, more karate lessons will further my understanding, but as it stands, my definition is:

Logistics is the art and science of acquiring, using, and disposing of the five elements—communication, personnel, materiel, infrastructure, and distribution—needed to complete a task, service, mission, or operation.

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notable quotes

We have petitioned We have entreated We have begged We beg no longer; we entreat no more; we petition no more! We defy them.

—William Jennings Bryan

From a 21R assignment team perspective, we have adjusted our business practices by managing the career field on a major command basis. Furthermore, when matching officers to assignments, we carefully balance the requirements of what a unit is looking for in an officer's background with the impact the potential assignment will have on the officer's development as a logistics readiness officer. This is a new dynamic of our matching process, but in the interest of developing a new caliber of logistics officers, we believe we are up to the challenge. We are committed to meeting, as best we can, field commanders' requirements.

The logistics career field is undergoing significant changes in the way an officer is educated, as well as developed, in the

workplace. Additionally, documentation verifying proficiency will be required where no such documentation existed before. While logistics readiness officers will be concentrating on breadth across a number of areas, aircraft maintenance and munitions officers will be focusing on gaining greater depth of experience. By being mindful of these concepts, we, as your assignment team, will do our utmost to bring you the right people, at the right place, at the right time.

Notes

1. Air Force Instruction 36-2105, *Officer Classification*, 31 Oct 02.

Captain Shirriff is a logistics readiness assignment officer, Air Force Personnel Center, Randolph, AFB, Texas.



Benefit and cost ratio =

$$\frac{PV}{I} = \frac{NPV + I}{I}$$

Clearly, if the definition of an acceptable project under the net present value is one with an NPV > 0, then an acceptable project must have a benefit and cost ratio > 1.0.

At first glance, one would think that the benefit and cost ratio is simply an alternative approach to expressing the very information of the NPV calculation. This is true for the pure accept or reject decision. However, this is not the case if the analyst is addressing alternative and mutually exclusive solutions to some logistics problem. In this latter context, the benefit and cost ratio is a more robust tool.

Consider two competing logistics investments. Project Alpha involves designing, acquiring, and implementing an automated storage-and-retrieval system to replace the existing materiel-handling system at a repair depot. Project Beta reflects minor upgrades to the existing materiel-handling system. Project Alpha has an initial cost of \$1M and generates cost avoidance (a reduced labor force) of \$300K per year for 10 years. Project Beta requires an investment of \$100K, just 10 percent of the outlay required for Alpha, and generates a cost avoidance of \$100K per year for 10 years. Neither project has a salvage value at the end of the 10-year period. Using a hypothetical cost of capital of 15 percent, the net present value for Alpha is \$505.7K; for Beta, \$401.9K.¹³ Under the net present value, Alpha is the preferred project.

The problem here is that the \$103.8K extra return on an incremental investment of \$900K is only an 11.53-percent yield. But the cost of capital is 15 percent.

This problem only arises with regard to ranking mutually exclusive alternatives and only then when alternatives being compared are of a substantially different size in initial investment. It has no bearing on the legitimacy of the net present value as an accept or reject decision rule for an independent project.

The benefit and cost ratio incorporates all the advantages of the net present value as a decision rule *and* corrects the ranking problem for projects of unequal investment size.

In the case of this example, the benefit and cost ratios are as follow:

Alpha

\$1,505,700/\$1M
= 1.5057

Beta

\$501.9/\$100K
= 5.019

Whereas the net present value gives preference to Alpha, the benefit and cost ratio gives preference to Beta, the alternative with the higher ratio. Why is Beta preferred? The return on investment is much better on Beta, given the proportionate size of the investment.

Conclusions

Logistics decisions frequently focus on assessing alternative strategies or courses of action (reflected in LSA tasks, for example) or accepting or rejecting some investment opportunity. Both situations require more than cost accounting. These are investment decisions requiring economics analysis: upfront costs must be accessed against future benefits or cost avoidance. Decision rule candidates for an economic analysis of alternative actions include the traditional methods of payback, naive rate of return and average return on investment, and the sophisticated methods of internal rate of return, net present value, and benefit and cost ratio.

The traditional methods of economic analysis, particularly the payback rule in its various forms, continue to enjoy popularity in both industry and the Department of Defense (DoD) because these decision rules are simple and straightforward.¹⁴ However, these methods are conceptually flawed because they fail to incorporate the time value of money.

Payback, in particular, is flawed on three fronts. It not only ignores the time value of money but also fails to account for returns after the payback period, and the accept or reject threshold (the required payback period) is arbitrarily set with no theoretical underpinnings.

Because money has a time value in the public sector, valid logistics decision rules in DoD must account for the Government's cost of capital by discounting time-distributed costs and benefits. The internal rate of return, net present value, and benefit and cost ratio incorporate the time-value of-money concept. Each of these approaches to economic analysis is conceptually valid and sophisticated, although the NPV rule is probably the most intuitively appealing and useful for the accept or reject decision for an independent logistics investment. When

the decision is made in the context of mutually exclusive alternatives, the benefit and cost ratio is the superior decision rule.

Logisticians, in facing the need for an economic analysis, should be deliberate in incorporating an appropriate rule when time-distributed costs or benefits are involved.

Notes

- [Online] Available: <http://tli.isye.gatech.edu>. The Logistics Institute, Georgia Institute of Technology also hosts seminars presented by FinListics Solutions, Inc, a training firm whose niche is measuring the impact of changes in logistics practices on overall financial performance and measuring and managing logistics capital investments in an organization.
- [Online] Available: www.clml.org. Visit this site for information on the *supply chain finance* track of the Council of Logistics Management Annual Meeting in Chicago, Illinois, 21-24 Sep 03.
- OMB Circular A-94, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*, 29 Oct 92. This policy is implemented in DoD Instruction 7041.3, *Economic Analysis for Decisionmaking*, 7 Nov 95.
- [Online] Available: http://www.whitehouse.gov/omb/circulars/a094/a94_appx-c.html, Appendix C, updated each January.
- The real rate of interest is the opportunity cost of capital independent of inflation. A nominal rate is the real rate, plus the rate of inflation. Each year, Appendix C of OMB Circular A-94 lists the real cost of capital to the Government and also lists the President's economic assumptions on inflation rates (Gross Domestic Product deflator) in the outyears. The addition of the inflation rate to the real rate defines the nominal rate. Decisionmakers in the Government, in making an economic analysis, are to use the real rate if costs and benefits of the project are expressed in constant dollars. If costs and benefits are measured in current (inflated) dollars, then the nominal discount rate should be used.
- Some proponents of payback argue that the rule is employed by design to emphasize the importance of liquidity in an investment decision (fast return of the investment). See J. Fred Weston and Eugene F. Brigham, *Essentials of Managerial Finance*, 10th ed, Fort Worth, Texas: The Dryden Press, 1993.
- "Select only LSA [Logistics Support Analysis] tasks that . . . project at least a 4-1 savings to investment ratio over a 5-year period of operation

. . . ." This proposed decision rule appeared in Lt Col Samuel Craig, "Logistics Support Analysis," *Program Manager*, Vol XV, No 1, Jan-Feb 86, 9-18.

- An improved approach to payback, *discounted payback*, has been developed. Under this scheme, the payback ratio is calculated with the present value of time-distributed net benefits in the numerator. This approach corrects for the criticism that payback ignores time value of money but the other shortcomings of payback remain. See Colin G. Hoskins and Glen A. Mumey, "Payback: A Maligned Method of Asset Ranking?" *The Engineering Economist*, Vol 25, Fall 1979, 53-65.
- Anthony F. Herbst, *Capital Budgeting*, New York: Harper and Row, 1982.
- Richard L. Meyer, "A Note on Capital Budgeting Techniques and the Reinvestment Rate," *The Journal of Finance*, Vol XXIV, Dec 75, 1251-1254.
- Doing an economic analysis in Government *requires* the employment of discount rates as specified by OMB. Nonetheless, the analyst should be aware of the debate as to what constitutes the true cost of capital to the Government. For instance, many economists consider the inflation rates in the President's economic assumptions (which must be used to convert real rates to nominal rates if the analysis requires nominal rates) to be more political than realistic. Additionally, most economists would argue that the discount rate appropriate for public sector economic analyses should reflect the *social cost of capital* concept and not the Treasury's borrowing rate. See Stephen H. Russell, "Discounting in Defense Decision Analysis," *The Air Force Comptroller*, Vol 19, No 3, Jul 85, 4-9.
- This shortcoming was first noted by C. G. Hoskins, "Benefit-Cost Ratios Versus Net Present Value: Revisited," *Journal of Finance and Accounting*, Vol 1, No 2, Summer 1974, 249-265.
- This example is adapted from Herbst, 82-83.
- An example of a continuing captivation with the payback concept is a 23 Oct 01 news release by CACI International, Arlington, Virginia, entitled "High Payback Opportunities for Future Logistics Investments: CACI Selected for \$47M Multiple Award Contract with Naval Supply Systems Command."

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(German Wonder Weapons continued from page 37)

opportunity to become and remain a truly advanced power. America is totally dominant in many factors but must continue its ongoing transformation process to stay ahead and provide unmatched military effectiveness.

Notes

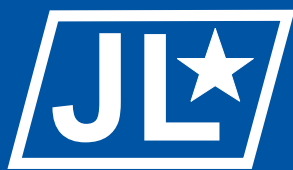
- Bill Gunston, *The Illustrated Encyclopedia of Combat Aircraft of World War II*, London: Salamander Books, Ltd, 1978, 74, 242.
- Generalleutnant Adolf Galland, *The First and the Last*, trans, Mervyn Savill, New York: Henry Holt and Company, 1954, 253.
- Jeffrey L. Ethell and Alfred Price, *The German Jets in Combat*, London: Jane's Publishing Company Limited, 1979, 60.
- Interrogation of Generalleutnant Galland, 16-18 Sep 45, typed transcript, 570.619A, in USAF Collection, Air Force Historical Research Agency (AFHRA), Maxwell, AFB, Alabama, 2.
- Interrogation of Hans Fay, test pilot for Messerschmitt, Me 262 jet-propelled aircraft and Me 163 rocket-propelled aircraft, 1 May 45, typed transcript, 170.2281-31, in USAF Collection, AFHRA, Maxwell AFB, Alabama, 3.
- Ethell and Price, 60-61.
- Galland, *The First and the Last*, 356.
- Ethell and Price, 60.
- The Diagram Group, *Weapons*, New York: St Martin's Press, Inc, 1980, 253.

- Alfred Price, *Luftwaffe Handbook 1939-1945*, New York: Charles Scribner's Sons, 1977, 50.
- Price, 53.
- Ethell and Price, 106-115.
- Interview of Dr Ing Hermann Lorenz (RLM), *Information on Natter German Rocket Interceptor*, 7 May 45, typed transcript, 170.2281-30, in USAF Collection, AFHRA, 1.
- Joachim Dressel, *Natter Ba-349*, Atglen, Pennsylvania: Schiffer Publishing, Ltd, 1994, 20.
- Diagram Group, 243.
- James F. Dunnigan and Albert A. Nofi, *Dirty Little Secrets of World War II*, New York: William Morrow and Company, Inc, 1994 54.
- Diagram Group, 253.
- Williamson Murray and Allan R. Millett, *A War to Be Won*, Cambridge, Massachusetts, The Belknap Press of Harvard University Press, 1983, 600.
- Dunnigan and Nofi, 54.
- David Irving, *The Rise and Fall of the Luftwaffe: The Life of Field Marshal Erhard Milch*, Boston: Little, Brown, and Company, 1973, 373.
- Generalfeldmarschall Erhard Milch, *An Apologia for the Defeat and Deficiencies of the Luftwaffe*, 15 Nov 45, 570.619B, in USAF Collection, Air Force Historical Research Center, Maxwell AFB, Alabama, 1. Milch states Hitler gained much of his aviation knowledge from his personal pilot, who was not much of an aviator or strategic expert. Hitler, not for the first time, trusted a close personal assistant instead of his true experts.
- Galland, *The First and the Last*, 340.
- Galland, *The First and the Last*, 331.

24. Irving, 232.
25. Irving, 219.
26. Galland, *The First and the Last*, 334.
27. Irving, 281.
28. Galland, *The First and the Last*, 314-315.
29. Irving, 298.
30. Richard Overy, *Why the Allies Won*, New York: W. W. Norton & Company, Inc., 1995, 202.
31. Overy, 201.
32. Overy, 201-202.
33. *Ibid.*
34. I. B. Holley, "Some Concluding Insights," *Air Superiority*, ed, B. Franklin Cooling, Washington DC, Center for Air Force History, 1994, 616.
35. Williamson Murray, *Strategy for Defeat of the Luftwaffe 1933-1945*, Maxwell AFB, Alabama: Air University Press, 1983, 5.
36. Irving, 335.
37. Murray, 6.
38. W. A. Jacobs, "Operation Overlord," *Air Superiority*, ed, B. Franklin Cooling, Washington, DC: Center for Air Force History, 1994, 275.
39. Overy, 240.
40. Murray and Millett, 535.
41. Overy, 204.
42. Price, 89.
43. Galland, *The First and the Last*, 352.
44. Interrogation of General Lieutenant Galland, *Special Weapons for Combating Four-Engined Bombers by Day with Single Engine and Twin Engine Fighters*, 14 Sep 45, typed transcript, 570.619A, in USAF Collection, AFHRA, Maxwell AFB, Alabama, 7. Ethell and Price cite similar information on pages 47 and 59, as does Perrett on page 253.
45. Hugh Morgan and John Weal, *German Jet Aces of World War II*, London: Osprey Publishing, 1998, 25.
46. Interrogation of German PoWs, ADI (K) Report No 44A/1944, *Hs 293 Radio Controlled Bomb*, 28 Dec 43, typed transcript, 512.6522, in USAF Collection, AFHRA, Maxwell AFB, Alabama, 3. Report No 1534 in the same location gives information on the FX radio-controlled bomb, gathered from eyewitness accounts of an attack and examination of a crashed Do-217K-3 and unexploded FX bombs in England.
47. Interview of Reichsmarshal Herman Goering, no date, typed transcript 570.619, in USAF Collection, AFHRA, Maxwell AFB, Alabama, 1.
48. Stephen L. McFarland and Wesley Phillips Newton, "The American Strategic Air Offensive Against Germany in World War II," *Case Studies in Strategic Bombing*, ed, R. Cargill Hall, Washington DC: US Government Printing Office, 1998, 204.
49. Morgan and Weal, 27-28.
50. William Green, *The Warplanes of the Third Reich*, Garden City, New York: Doubleday and Company, Inc., 1970, 641.
51. Green, 519.
52. Bruce D. Callander, "The Jet Generations," *Air Force Magazine*, 85, 10, Oct 02, 70.
53. Geoffrey Perrett, *Winged Victory*, New York: Random House, 1993, 411.
54. Irving, 244.
55. The Editors of Time-Life Books, *The Luftwaffe*, Alexandria, Virginia, Time-Life Books, 1982, 168.
56. Jacobs, 275.
57. Price, 64.
58. McFarland and Newton, 195.
59. Murray, 254.
60. Galland, 357-358.
61. Price, 64.
62. McFarland and Newton, 237. Overy (*Why the Allies Won*, 321) also states that by Sep 44, 80 percent of the Luftwaffe fighter force was based in Germany for antibomber missions.
63. Murray and Millett, 332.
64. Jacobs, 304.
65. Jacobs, 306.
66. Murray and Millett, 334.
67. Overy, 118.
68. Perrett, 293.
69. Galland, 356.
70. Morgan and Weal, 9.
71. Galland, 318.
72. Galland, 356.
73. John Keegan, *The Second World War*, New York: Penguin Books USA, Inc., 1989, 582.
74. Murray and Millett, 600.
75. Dunnigan and Nofi, 54. Keegan cites similar numbers.
76. H. E. Bates, *Flying Bombs Over England*, Westerham, Kent, England: Froglets Publications Ltd, 1994, 156.
77. Keegan, 582.
78. Gunston, 103.
79. Dunnigan and Nofi, 212.
80. Price, 89.
81. Interrogation of German PoWs, A.D.I. (K) Report No 2246, *German Flying Bomb* (no date, typed transcript, 512.6521, in USAF Collection, Historical Research Agency, Maxwell AFB, Alabama, 1. Also contains information from examination of downed and captured V1s.
82. Dunnigan and Nofi, 211.
83. War Department Memo, HQ AAF, *German Pilotless Aircraft*, 8 Jul 44, 142.0423-5, in USAF Collection, AFHRA, Maxwell AFB, Alabama, 3.
84. Price, 89.
85. Crossbow report, *Study: Flying Bomb and V2 Rocket*, 8 Jan 45, 142.0423-4, in USAF Collection, AFHRA, Maxwell AFB, Alabama, 3.
86. Keegan, 581.
87. Earl R. Beck, *Under the Bombs*, Lexington, Kentucky: The University Press of Kentucky, 1986, 115-116.
88. Crossbow, 1.
89. Bob Ogley, *Doodlebugs and Rockets, The Battle of the Flying Bombs*, Froglets Publications Ltd, 1992, 50.
90. Overy, 239-240.
91. Report from Captured Personnel and Materiel Branch, US War Department Intelligence Division, *Trends in Development of German Weapons for Countering Allied Bombers*, 5 May 45, 170.2281-23, in USAF Collection, AFHRA, Maxwell AFB, Alabama, 2.
92. Dieter Holsken, *V-Missiles of the Third Reich, the V1 and V2*, Sturbridge, Massachusetts, Monogram Aviation Publications, 1994, 245-256.
93. Holsken, 261-262.
94. Overy, 240.
95. John A. Tirpak, "The Force Seeks a New Baseline," *Air Force Magazine*, 86, No 1, Jan 03, 40.
96. Tirpak, 39.
97. Benjamin S. Lambeth, *The Transformation of American Air Power*, Ithaca, New York: Cornell University Press, 2000, 305.
98. Donald H. Rumsfeld, "Transforming the Military: Riding into the Future," *National and International Security Studies*, Maxwell AFB, Alabama: Air Command and Staff College, 2002, 147.
99. "Long Arm of the Air Force," *Air Force Magazine* 85, No 10, Oct 02, 30.
100. "Long Arm of the Air Force," 31.
101. "Long Arm of the Air Force," 33.
102. Lambeth, 303.
103. HQ USAF XPXT, "The USAF Transformation Flight Plan, In *Joint Force Employment*, Maxwell AFB, Alabama: Air Command and Staff College, 2003, 54.
104. Rumsfeld, 149.
105. Rumsfeld, 145.
106. James G. Roche, "Transforming the Air Force," *Joint Force Employment*, Maxwell AFB, Alabama: Air Command and Staff College, 2003, 10.
107. Maj T. W. Beagle, "Effects-Based Targeting: Another Empty Promise?" in *Air and Space Operations*, Maxwell AFB, Alabama: Air Command and Staff College, 2002, 77.
108. Murray and Millett, 534.
109. Lambeth, 320.
110. Irving, 334-335.

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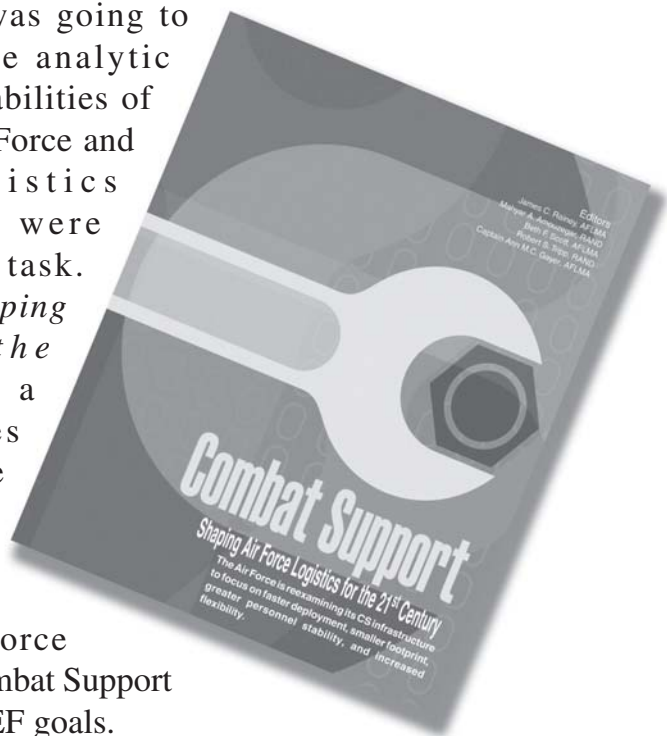
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In 1996, shortly after Operation Desert Strike, concern about the long-term requirements of enforcing the no-fly zones, including covering *the carrier gap*, led to the initial concept of an air and space expeditionary force. At that time, the Deputy Chief of Staff, Operations, Lieutenant General John P. Jumper, realized that transforming the Air Force to a more expeditionary footing was going to require comprehensive analytic study. The unique capabilities of both RAND Project Air Force and the Air Force Logistics Management Agency were harnessed to take on this task. *Combat Support: Shaping Air Force Logistics for the 21st Century* is a compilation of articles that communicates the essentials of the analyses completed over the last 6 years. The research was conducted to help the Air Force configure the Agile Combat Support system in order to meet AEF goals.



Combat Support C2 Architecture

Robert S. Tripp, PhD
Patrick Mills; Amanda Geller
C. Robert Roll, Jr, PhD
Major Cauley von Hoffman, USAF
Lieutenant Colonel David L. Johansen, USAF
James A. Leftwich

The Editorial Advisory Board selected "Combat Support C2 Architecture"—written by Robert S. Tripp, PhD; Patrick Mills; Amanda Geller; C. Robert Roll, Jr, PhD; Major Cauley von Hoffman, USAF; Lieutenant Colonel David L. Johansen, USAF; James A. Leftwich—as the most significant article to appear in Vol XXVII, No 2 of the *Air Force Journal of Logistics*.